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Research Report 1842

Computer-based Approaches for Training Interactive Digital Map Displays

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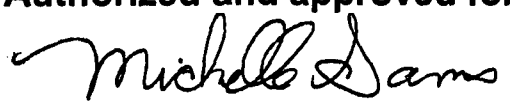

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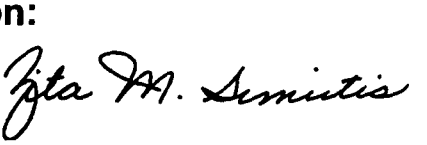

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14. ABSTRACT *(Maximum 200 words)*: Five computer-based training approaches for learning digital skills were compared using OSUT and IOBC Soldiers. The pure exploratory condition was the least effective for all Soldiers, particularly those in OSUT. The traditional lesson and exercise combination was effective for all as was the guided-exploratory, problem-solving condition. The condition where Soldiers could select their own mode(s) of training produced different training strategies on the part of the OSUT and IOBC Soldiers. IOBC Soldiers used more consistent and fewer training strategies than did OSUT; this condition was preferred by IOBC. OSUT Soldiers benefited from the more structured environments that provided performance feedback. IOBC Soldiers did not necessarily require exercises, but did benefit from the lesson information and the capability to control their training strategy. The findings reinforce the need to tailor training to Soldiers when the target population is diverse, and common skills and knowledge must be acquired. The results suggest that giving the same training to all is not the most efficient, nor the most effective, nor the most motivating.

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COMPUTER-BASED APPROACHES FOR TRAINING INTERACTIVE DIGITAL MAP DISPLAYS

EXECUTIVE SUMMARY

Research Requirement:

With the proliferation of digital capabilities in the Army's combat systems, using some form of computer-based training (CBT) to train digital skills is becoming relatively common. The underlying issue is not whether CBT should or will be used, but how it can be designed to be effective for the broad military target audience that operates and employs these tactical systems. Prior research had shown a need to examine more than the traditional format of lessons (instruction) followed by exercises, and the other extreme of letting Soldiers learn a digital interface on their own. The research reported here examined these two conditions and three other training approaches with two distinct target populations, junior officers and privates. The digital skills trained were those that involved using a digital map interface to solve tactical problems.

Procedure:

Five variations of CBT for learning to use functions underlying a digital map interface were compared. The variations were: a pure map exploration condition, a lesson followed by exercise condition, a guided-exploratory condition where the map functions were learned through solving problems, a lesson followed by map exploration condition, and lastly a condition where Soldiers could select the mode(s) of training they preferred. Soldiers from Infantry One-Station-Unit Training (OSUT, $n = 85$) and the Infantry Officer Basic Course (IOBC, $n = 67$) were randomly assigned to these conditions. The first phase of the experiment was common training on individual and unit symbols used in the map application. The map phase involved seven map functions. Criterion measures were scores on the map exam and times required for map training and testing. Soldiers were also queried regarding their reactions to their map training. Special analyses were made of the training strategies used by the Soldiers assigned to the Self-Select condition.

Findings:

The pure exploration condition was the least effective training for both groups of Soldiers, but particularly for those in OSUT. All Soldiers performed well under the traditional lesson and exercise combination. The guided exploratory, problem-solving condition whereby Soldiers learned the functions through executing exercises and receiving feedback on their performance was also effective for both groups. The condition where Soldiers could select their mode(s) of training produced quite different training strategies on the part of the IOBC and OSUT Soldiers, with the IOBC Soldiers selecting fewer and more consistent modes of training. This condition

was the one most preferred by IOBC, whereas the lesson and exercise condition was the most preferred by OSUT Soldiers.

Utilization and Dissemination of Findings:

The findings indicate that CBT can be used to implement quite different approaches to training. They also support the premise of the research that Soldiers who form an Infantry platoon react differently to training approaches that reflect dissimilar, yet valid training philosophies. OSUT Soldiers benefited from more structured training environments with performance feedback on practical exercises and tasks. IOBC did not necessarily require application exercises, but did benefit from the lesson information and the capability to control/select their training strategy. It is possible that the self-choice CBT approach used in the experiment could be modified to better accommodate different segments of the military target population. However, additional research is needed to verify that such modifications are effective. The findings reinforce the need to tailor training to Soldiers when the target population is diverse, and common skills and knowledge must be required. Giving the same training to all is not the most efficient, nor the most effective, nor the most motivating.

COMPUTER-BASED APPROACHES FOR TRAINING INTERACTIVE DIGITAL MAP DISPLAYS

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Introduction

The across-the-board fielding of digital technology within the Army requires developing effective and efficient training for the Soldiers and leaders who must function in an information-rich environment on the battlefield. Well-trained Army personnel are essential for maximizing the efficiency and effectiveness of this technology. With many of the Army's digital systems, Soldiers of varying ranks and military experience are expected to master the same software. Training should adapt to the potential differences within this target population.

The stimulus for the current experiment was the Army's Land Warrior system, now known as the Ground Soldier System (GSS), which involves a wearable computer with a helmet-mounted display. Every Soldier has a global positioning system, and is networked with all individuals in the unit. Soldiers can see a digitized map of the terrain on which their location, the location of others, and graphic control symbols related to the mission can be shown. The system will be used by privates, noncommissioned officers, and officers from different branches of the Army (e.g., Infantry, Medics, Engineers, Field Artillery).

By definition, in order to train Soldiers on the computer or digital skills required by such tactical systems, Soldiers must use a computer. At a minimum this would involve initial instruction given in the context of an instructor-led classroom presentation or an instructor behavioral modeling approach (Gist, Schwoerer, & Rosen, 1989). With the modeling approach, the instructor shows how to do a task and Soldiers then practice the task. However, use of "stand-alone" computer-based training (CBT) programs (also known as interactive multi-media instruction [IMI] or interactive courseware [ICW]) offer an alternative approach to instructor-led training. With CBT, the instructor is removed from the training setting, with both the instruction and practice provided by the CBT program.

The current research examined different approaches to training using CBT. It did not compare CBT with another instructional medium. It was assumed that CBT had the advantage of allowing Soldiers to progress at their own rate (Fletcher, 2003; Gibbons & Fairweather, 2000) regardless of the instructional design or the psychological principles underlying the training. This was an important consideration given the diverse military target population for the GSS. Computer-based training approaches provide one means of tailoring training to distinct segments of the GSS target population. Further, CBT applies directly to learning how to operate digital systems.

Much CBT research has compared CBT with more traditional methods of training (Fletcher, 2003; Gibbons & Fairweather, 2000). In general, these efforts have not focused, for example, on varying the extent to which the CBT is learner-centered or highly structured, on techniques designed to vary the learner's degree of active thinking with the content, or how such variations in training approaches might be best accomplished via CBT.

In addition, much of the research on CBT has been conducted in academic settings. There are at least two critical factors that distinguish these research settings from the military setting. First, the samples of individuals participating in CBT research in academic settings often represent a narrow segment of the entire population of potential users of CBT; the samples are restricted. For example, the sample can be entirely of sixth-grade students or of college students who have volunteered for extra course credit. Second, as pointed out by Gibbons and Fairweather (2000), training in the military or an industrial setting often has a different goal from that in school settings. In military or industrial settings the content is on domain-specific tasks (e.g., maintenance of a piece of equipment) versus the general skills of interest in academic settings. Time to master the domain is a critical variable in the military or industry, while time is not as critical in academic settings.

Accordingly, there is relatively little empirical research on the effects of different instructional designs or approaches as applied to CBT, and on what works best for individuals with differing experience or backgrounds related to the skills to be trained or whether such demographic factors make a difference. The research described in this report examined these issues. The experiment compared different means of training skills necessary to use a digital map display in tactical settings using CBT with two distinct groups of Soldiers. Two distinct groups of Soldiers participated in order to determine if the training conditions had similar or different effects with these groups, both of which were in the target population of interest. It was a follow-on effort to the Dyer and Salter (2001) experiment that examined training the same digital map skills.

Common Training Approaches

Clark and Wittrock (2000) outlined four typical approaches used in industrial training environments, which also apply to military training and to the experiment reported here. These four were called:

- Receptive: Teaching by telling
- Behavioral: Teaching by rule, example, practice, and feedback
- Guided Discovery: Teaching by problem solving
- Exploratory: Teaching by exploration

These learning environments were placed (in the order presented above) on an external to internal continuum with the receptive approach focusing on the external object of instruction and the exploratory approach focusing on the internal mental environment of the learner.

The reception approach (teaching by telling) is typified by what can be considered a "lecture" approach, whereby an instructor gives learners information (verbally, via diagrams) and learners can ask questions. Clark and Wittrock also described this as a telling of principles approach. For this approach to be effective, instructors must be cognizant of the learner's prior knowledge and background to relate the material to the learner and enhance comprehension. If this does not occur, the instructor may overload learners with information or the learners may not comprehend the material because it does not relate to their own knowledge or experience.

With the behavioral approach (teaching by rule, example, practice, and feedback), the instructor presents the basic rules and principles, but the learners apply these rules and principles in the context of practice exercises either individually or in teams. The instructor monitors these exercises, coaches, and provides feedback during and after the exercises.

With the guided discovery approach (teaching by problem solving), learners are assigned a specific problem, and are expected to use prior knowledge to solve the problem as a group. The instructor provides tutorials as needed, coaching, and feedback. As described by Clark and Wittrock, learners acquire skills through collaborative problem-solving and coaching from experts. This approach assumes learners will make errors, but also that they have the opportunity to correct errors, and thereby improve their performance, which in turn should improve comprehension and retention.

The last approach cited by Clark and Wittrock was exploratory (teaching by exploration). This approach relies on the learner to acquire the necessary information and skills, rather than having the information and skills "imposed" on the learner. Instructional materials could be available via the Internet, the learner could make queries of the instructor upon request, etc. The learner is in control, not an instructor. For this approach to be effective, learners must possess the necessary metacognitive skills and the ability to take responsibility for their own learning.

Clark and Wittrock compared their four approaches on several dimensions other than the external to internal continuum. With the receptive approach, learners are primarily receivers of information from the instructor, and the content to be learned is presented in a highly structured format. With the behavioral approach the learner learns through carefully presented stimuli and exercises and is given immediate feedback by the instructor, as is typical of most programmed instruction. With the guided discovery approach, learners are put in a problem-solver mode, learn through case-based situations and from their own errors, with both intrinsic feedback and external feedback from the instructor who serves as a coach and mentor. With the exploratory approach, learners must take a very active role in their learning process, must build or develop their own knowledge representation of the content, and the instructor provides resources as requested. Obviously, these approaches reflect different assumptions regarding the learning process and the abilities required of the learner for the approach to be effective.

Kanfer and McCombs' (2000) discussion of motivation and training also relates to these training approaches. From a broad perspective, considering entire courses of instruction, learners will perform better if they perceive themselves as having some control over the learning environment; situations where they are not totally passive recipients of instruction and may not be able to influence the pace of training. In addition, Kanfer and McComb point out that metacognitive processes ("thinking about one's learning activities and processes" [p. 89]) have a role in learning and performance. Metacognition also involves the planning and selection of appropriate learning tactics, monitoring and evaluation of one's progress, and changing approaches when needed (Clark & Wittrock, 2000). It would appear that to the extent that an instructional approach places greater responsibilities on the learner, the role of metacognition becomes increasingly important. Metacognitive skills also impact how hard and long the learner will continue to work on tasks (Kanfer & McCombs, 2000).

Clark and Wittrock (2000) stressed that the primary question is not which approach is best, but which approach is best for learners with different backgrounds and experience, and for the skills of interest. This latter question was addressed in the experiment reported here.

Prior Training Research With a Digital Map Interface

Dyer and Salter (2001) varied the load on working memory of Soldiers as they learned individual Soldier and unit symbols, and seven functions fundamental to operating a tactical digital map interface. CBT lessons that contained a large volume of information (high-demand memory task) were compared with lessons where information was divided into smaller chunks (low-demand memory task). The high- and low-demand conditions were used for both symbols and map training. Both high- and low-memory demand conditions consisted of lessons followed by practice exercises where Soldiers had immediate feedback on their performance. The difference between these two conditions was the amount of material covered in a given lesson, although everyone had to learn the same material before completing the training. Dyer and Salter also examined an exploratory method of learning the map functions to determine if Soldiers could learn the map functions on their own. Participants were Infantry Soldiers from the Infantry One Station Unit Training (OSUT), Basic Noncommissioned Officer Course (BNCOC), Advanced Noncommissioned Officer Course (ANCOC), and Infantry Officer Basic Course (IOBC).

In the exploratory mode of learning the map, Soldiers had minimal guidance and information. They were informed of the seven map functions they had to learn, and were shown the location and purpose of each function's corresponding button (icon) on the map. However, they had no instructions on how to use the buttons to perform tasks with the map display. When they explored or worked with the map, they received no feedback on their performance. Each Soldier could elect to take the map exam when he thought he had learned the functions. This exploratory mode was examined to test the often-heard statement that Soldiers can decipher how a software interface works on their own. If an exploratory mode of training worked for Soldiers, then it would provide considerable training flexibility.

Dyer and Salter (2001) found that the low-demand working memory condition was more effective than the high-demand condition, especially for the symbols training and for one of the map functions. In addition, the exploratory condition of learning the map interface was the least effective for all groups of Soldiers, but it required the least training time. The greatest differences in performance on both the symbols and map exams was between the IOBC and the OSUT Soldiers, with the IOBC Soldiers scoring higher on average and taking less time to complete the training.

The low-demand working memory condition in the Dyer and Salter (2001) experiment corresponded very closely to Clark and Wittrock's (2000) behavioral approach (learning by rule, example, practice, and feedback). Dyer and Salter's exploratory condition corresponded most closely to Clark and Wittrock's exploratory approach, although it was all individual, computer-based instruction. It did not involve the Internet, collaborative learning with others, did not provide access to instructors, etc. It did place total responsibility for learning on the Soldier, and

the Soldier's metacognitive skills to assess whether the functions had been examined completely and were understood.

The Dyer and Salter (2001) findings raised two main questions. One was whether forms of guided exploratory training that incorporated some elements of formal instruction and feedback would be more effective than the free exploratory training that was investigated. The second question was how these other approaches to CBT would impact different segments of the Soldier target population. In that regard, it was decided to examine two variations of guided exploratory learning, similar to Clark and Wittrock's (2000) guided discovery (learning by problem-solving) approach. An additional condition where each Soldier selected his mode(s) of training was included. The experiment also replicated the low-memory demand and the pure exploratory conditions used by Dyer and Salter.

Variations of Exploratory Training

Effectiveness of Exploratory Training Approaches

Research shows exploratory training has advantages and disadvantages. Reported advantages are improved transfer of learning (Carroll, 1997; Egan & Greeno, 1973; Kamouri, Kamouri, & Smith, 1986), and that it can be accomplished more quickly or in the same amount of time as traditional modes of instruction (Carroll, 1997, Kamouri et al., 1986). Reiser, Copen, Ranny, Hamid and Kimberg (1998) found that exploratory learning led to higher intrinsic motivation for high ability individuals.

One reported disadvantage of exploratory training is that it is not necessarily effective with novices. In exploratory training, the instructional environment requires a high level of learner control and novices perform better under more directive training strategies (Clark & Wittrock, 2000). Several examples of this finding are given here. Egan and Greeno (1973) found that individuals with low math ability did better in a highly-structured ruled-based training approach to learning binomial probabilities. Similarly, Shute, Lajoie and Gluck (2000) stated that lower ability individuals may require more support than that provided in an exploratory environment, whereas high ability individuals may do well.

Charney, Reder and Kusbit (1990) stated that learners using an exploratory mode of training may have difficulty evaluating their progress, and that it is not easy to provide feedback to learners who set their own goals. Learners may retain misconceptions that do not quickly produce salient errors; they may not be able to evaluate quality of their solution. Other potential drawbacks are "exploratory traps" (Payne & Howes, 1992), where individuals may select inefficient methods or fail to determine the best steps for completing a task. Individuals may not possess the necessary information-seeking or metacognitive skills (Wallace, Kupperman, Krajcik, & Soloway, 2000) to optimize performance in an exploratory environment. They may fail to uncover important principles (Ausubel, 1963). They may not be able to recognize what they do not know, nor how to work within the environment to enhance their understanding and performance (Briggs, 1990).

In examining individuals' ability to conduct electronic searches, Debowski, Wood and Bandura (2001) found that individuals who practiced in a self-guided exploratory mode performed at a lower level, had less effective search strategies, and made more errors than those trained in a guided-exploratory mode. In the self-guided exploratory mode, individuals had limited feedback on their search strategies. In the guided exploratory mode, individuals progressed from easy to difficult searches and were instructed to work systematically using a specific search strategy. Debowski et al. concluded that lack of informative feedback from an unguided or self-exploration search mode caused individuals to remain at a novice level of skill.

Reiser et al. (1998), in their summary of a comparison of discovery learning and guided learning with college students, concluded the following:

> Discovery learning provides more opportunities for students to control their own learning. The potential cognitive benefits of this control are the opportunity to employ more effective learning strategies and to better learn error management skills, but the potential costs are the acquisition of less efficient strategies and the possibility of failing to exercise important components of the skill. The potential motivational benefits are increased confidence in one's ability to handle challenges and perhaps an increased interest in the domain, but the potential costs are conclusions about one's ineffectiveness and a corresponding loss of interest in the domain. Overall, with more at stake, there appears to be more to gain for the high ability students, but also more to lose for the low ability students (p. 52).

Some research has shown that guided discovery (exploratory) environments have benefits (DeMul & Van Oostendorp, 1996; Trudel & Payne, 1995; Van Oostendorp & DeMul, 1999). Although these were not CBT environments, the findings could apply to this method of training. Charney, Reder and Kusbit (1990) did investigate modes of CBT which included two variations of exploratory training. The exploration mode allowed individuals to experiment at will, setting their own goals, and selecting and applying procedures (learner-initiated). A "problem-solving" group was presented sets of training problems which had to be solved by working with the interface; feedback was provided after working each problem. The third method was a tutorial mode of training. The problem-solving mode took more time than the other two methods, but resulted in faster and more successful performance on a test two days later.

An approach described by Schaab, Dressel and Moses (2004) for training high-ability Soldiers at Fort Huachuca on one of the Army's digital software systems is another example of Clark and Wittrock's (2000) guided discovery (teaching by problem solving) category. In this case, Soldiers worked in small teams to solve tactical problems while instructors served as coaches and mentors. Soldiers successfully applied what they learned via this method to a novel set of problems using the digital system.

Experiments examining exploratory training vary in how the extent of exploration is operationally defined. At one extreme, learners can be almost entirely on their own (often called self-guided exploration or free exploration). With guided exploratory training, more guidance and support is provided in the form of feedback, problem solving exercises, etc. But in all cases,

learners must have an active role in the learning process in order to build their own knowledge structure of the content and master the required skills.

Training Digital Map Skills with Forms of Exploratory Training

The "pure" exploratory training findings in the Dyer and Salter (2001) experiment were consistent with the Debowski et al. (2001) and Reiser et al. (1998) findings and review of literature on electronic computer search training. All found that the lack of external feedback and of a structured learning environment inhibits acquisition of skill and task understanding for many. This "pure" exploration condition was replicated in the current experiment.

Two other conditions in the current experiment were considered a form of guided exploratory/discovery training as both fell between the "exploratory" and "behavioral" categories on Clark and Wittrock's continuum, that is, their "guided discovery" category. One of the guided exploratory training conditions was similar to the "problem-solving" condition in the Charney et al. (1990) research, and Clark and Wittrock's (2000) description of guided discovery in that Soldiers learned map functions via solving problems. Several practical exercises on each map function were presented, and Soldiers were provided immediate feedback on their exercise performance. There was no formal instruction or lessons on the functions.

The other variation of guided exploratory training had Soldiers take lessons on each function, i.e., Soldiers were recipients of information. After each lesson they then worked with the digital map interface on their own to actually determine or "discover" how each map function actually worked. Neither feedback nor exercises were provided during this exploratory phase. This was considered a form of guided-exploratory training as Soldiers had a foundation from which they could explore the map, in contrast to the "pure" exploratory condition in the Dyer and Salter (2001) experiment. Soldiers had information on the purpose of each map function and how each worked, which could be applied to the software interface.

Training Digital Map Skills with a Self-Selected Approach

In an attempt to adapt to the differences in the backgrounds and skills of the military target population who employs digital systems, we investigated a training procedure that allowed Soldiers to select or choose their mode(s) of training (lessons, exercises with feedback, working with the map, or any combination of these modes). We postulated this would be a means whereby a single computer software program could adapt to the diversity of expertise, and to the learning styles and preferences in the target population, which included privates, noncommissioned officers, and officers.

This approach, however, placed the burden of determining a learning strategy on the learners and their metacognitive skills. To be effective, Soldiers needed to understand what techniques of training worked best for them, and to adjust their strategy as needed during the course of training. It was up to the Soldiers to determine the mode(s) of training that facilitated their learning of the map functions. This approach was assumed to motivate Soldiers (Kanfer & McCombs, 2000), as they now had some degree of control over their learning environment. It did not fall directly on the continuum postulated by Clark and Wittrock (2000), although it

incorporated a learner- centered component in that a particular mode of training was not required. The mode of training was the Soldier's choice. In our search of the literature, we found no examples of this approach to CBT.

Purpose

The purpose of the experiment was to compare the effectiveness of five approaches to CBT technology to train two distinct samples of Soldiers on digital map functions that are typically embedded in many of the Army's tactical digital systems. Soldiers had to use the map functions to solve tactical problems representative of those required in the field. Soldiers' reaction to the instructional approaches was examined. In addition, from a practical perspective, it was important to know which instructional design approach would be best to incorporate in CBT when training developers actually design programs of instruction for military personnel on other digital skills.

The multiple instructional approaches ranged from "instructor-centric" to "learner-centric" thereby expanding on the two instructional approaches examined in the Dyer and Salter (2001) work. Soldiers participating in the experiment were from IOBC and Infantry OSUT, as these groups represented the two groups that differed the most on training performance and time in the Dyer and Salter experiment.

Method

Experimental Design

The experimental design is depicted in Table 1. The experiment was divided into two phases, symbol training followed by map training. It was necessary for the Soldiers to learn symbols, as they were essential to identifying the icons on the map display. In the first phase, Soldiers were trained on symbols as was the case in Dyer and Salter (2001). However, all Soldiers had the same symbol training, whereas in the Dyer and Salter experiment there were two symbol training conditions. Soldiers took a final exam on symbols after completing symbols training. Then Soldiers were randomly assigned to one of the five map training conditions as shown in Table 1. All were given the same map final exam at the conclusion of the training. The symbol training and map training are explained in the following sections.

Symbol Training

Scope of the training. In the symbol training, Soldiers learned battle roster (BR) and standard Army symbols which in combination uniquely identified individual duty positions and small units. These code combinations were developed by Dyer and Salter (2001), and are described in Appendix A. They were based on the Army's battle roster system (Department of the Army [DA], 1994). For individuals, these codes integrated the standard Army graphics for weapons (FM 101-5-1, DA, 1997). For units, the codes integrated the standard Army graphics for units. The codes provided unique designations for individuals and units at the squad, platoon, and company echelons. Examples of individual and unit codes are in Figure A-1.

Table 1
Experimental Sequence and Design

Symbol Training and Exam *Four Sets of Lessons with Exercises with Final Exam*				
Map Training Conditions				
Explore Map Only ↓	**Explore via Exercises** ↓	**Lesson then Explore** ↓	**Lesson and Exercise** ↓	**Self-Select** ↓
Explore map freely (No lessons and no exercises)	Solve exercises by exploring map. Repeat for each topic. Optional full exploration.	Lesson then explore map. Repeat for each topic. Optional full exploration.	Lesson then exercise. Repeat for each topic	Choice of lesson, exercises, and/or exploring map. Any combination in any order. Repeat for each topic.
Map Final Exam				

As in Dyer and Salter (2001), five weapon symbols and three unit symbols, as well as the BR numbering system, were taught. The symbol training was divided into four sets of lessons with exercises: weapon and unit symbols, battle roster numbering system, rifle squad members, and key leaders and units. Soldiers had to learn the code combination for each of the nine individuals within an Infantry squad, the platoon leadership, and the company leadership. They also had to learn the coding scheme for units at the squad, platoon, and company levels. Each lesson concluded with an exercise with feedback on Soldier performance. However, unlike Dyer and Salter (2001), Soldiers were not required to take remedial training if they scored less than 80% on the exercises. After completing all lessons and exercises, the Soldiers took a symbol final exam.

A summary of each symbol lesson is in Appendix A. Except for a few variations, the lesson content, exercises and exam were the same as those used by Dyer and Salter (2001). A new training technique was introduced in the present experiment. This was the inclusion of "think-ahead" questions in the lessons in an effort gain Soldier attention and involvement. This was a technique that could be included in any computer-based training lesson.

Think-ahead questions. The think-ahead questions required Soldiers to figure out the answer to a question prior to being taught the concept behind the question. The reason for including these questions was to make the lesson material less passive from the Soldiers' perspective and to involve them in reflecting about the material. Furthermore, as these think-ahead questions were interactive, they kept Soldiers more involved in their tasks. These factors were intended to enhance the Soldiers' understanding of the material and their motivation to learn it. Figure 1 illustrates one think-ahead question. In this case, the Soldier was asked to identify the graphic symbol for the M240B machine gun before being taught this material. This is a multiple-choice item where three weapon symbols are depicted.

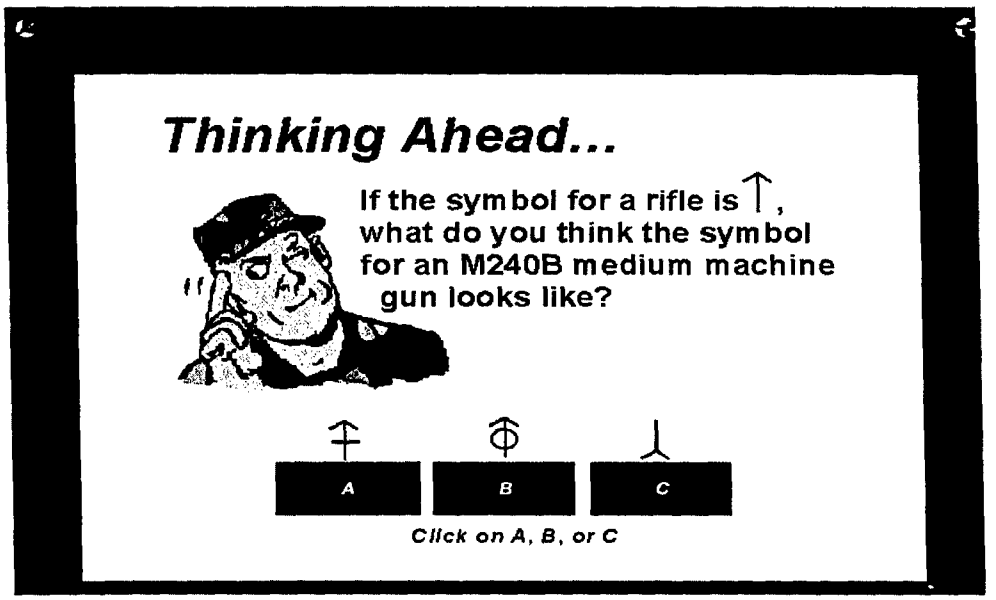


Figure 1. An example of a think-ahead question.

Map Functions Training

Seven map functions were taught: Zoom-In, Zoom-Out, Pan, Find Me, locate individuals and units using the Find X function, pre-mission set-up for Display, and determine Range and Azimuth. Figure 2 illustrates the map display. With the exception of Range/Azimuth, the icons or buttons for each function were on the top toolbar above the map display itself. The Range/Azimuth button was at the bottom of the map display. The seven map functions were the same map functions examined by Dyer and Salter (2001). Each map function is described next.

-Zoom-Out. By clicking on the Zoom-Out button, the map zoomed out to increase the area of the map shown on the display. In other words, more of the map was displayed by zooming out and the features that were not displayed earlier (if they were outside the displayed area) could be displayed on the map. It was a one step process; one click on the Zoom-Out button and the map zoomed out.

-Zoom-In. This function was used to zoom in on the map, or any feature on the map. It decreased the area of the map displayed (i.e., magnified it) to provide greater details of the area of interest. The Zoom-In function also recentered the map display on the area of interest. This function required two steps after the first click on the Zoom-In button. After clicking on the Zoom-In button, Soldiers then had to click on the map (or any feature on the map) to completely activate the function. To deactivate the function, Soldiers had to click on the Zoom-In button again.

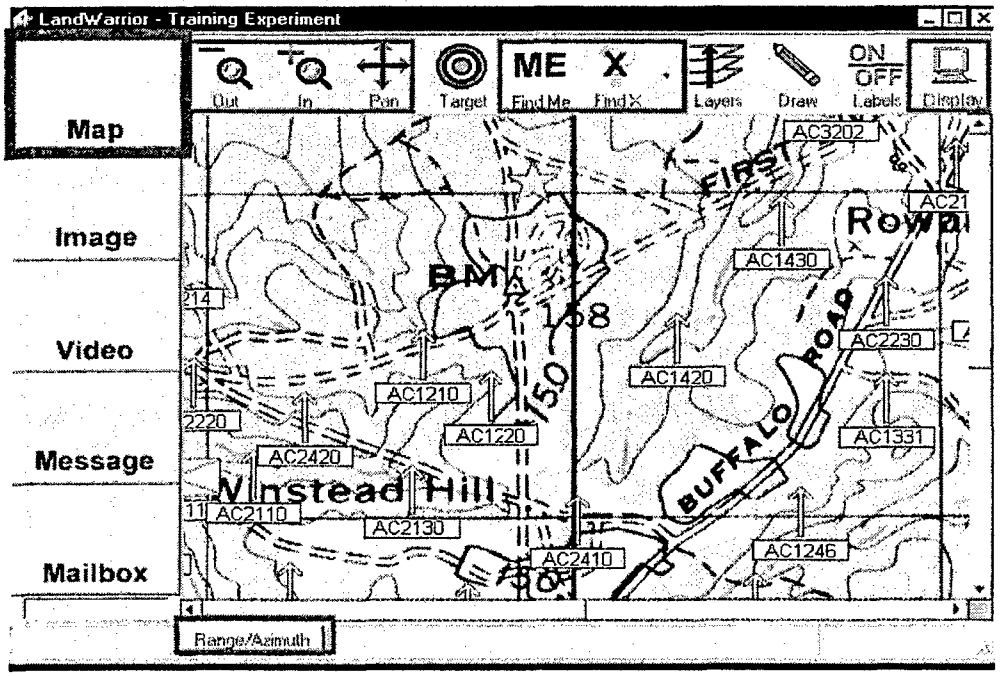


Figure 2. Map display. [Functions included in the experiment are outlined with a thick line.]

-*Pan.* The Pan function allowed Soldiers to move the displayed map east, west, north or south. Similar to the Zoom-In function, the Pan map function also required two additional steps from Soldiers after the first click on the Pan button. After clicking on the Pan button, Soldiers then had to click on the map to move the map display in the desired direction. To deactivate the function, the Pan button had to be clicked again.

-*Find me.* The Find Me function was used to locate the Soldier using the map and to re-center the map on this Soldier. A blue colored star on the displayed map represented the participating Soldier. This function was a one-step function; one click on the Find Me button and the map display re-centered to show the Soldier as a blue star. This blue star can be seen at the top of the map display in Figure 2.

- *Locate individuals and units using the Find X button.* This function allowed the Soldier to locate a specific Soldier or unit on the map display. The Find X button triggered a series of embedded menu selections. These embedded menus allowed Soldiers to maneuver with the unit hierarchy to find the unit or individual of interest. They could find the unit of interest, go to a lower echelon, go to the higher echelon, find individual Soldiers, and find leaders at a specific echelon.

- *Pre-mission set-up for Display.* This function was similar to Find X function, as it displayed Soldiers and units. However, the function allowed the Soldier to select the individual and units deemed necessary to track during the mission. Multiple Soldiers or units could be displayed rather than the single Soldier or unit associated with Find X. They could

also remove Soldiers and units from showing on the display if desired. The Display button also triggered a series of embedded menu selections, starting at the company level, to enable the Soldier to make the appropriate selections. Soldiers could traverse or navigate within the menu hierarchy to the lowest echelon where an individual Soldier(s) from a squad could be displayed. At any point the Soldier was allowed to traverse to a higher echelon in order to select units and individuals/leaders for display.

- *Determine range and azimuth.* This function involved determining the range and azimuth between different map features (e.g., units, Soldiers, terrain features, landmarks). Two clicks were required; one click for the first location or point, and another click for the second location or point for which range and azimuth readings were desired. Soldiers had to know where to click on individual or unit symbols to get accurate range and azimuth readings. A third click was required to cancel the function.

In the map training, with the exception of the condition where Soldiers simply explored the map, the first four functions (i.e., Zoom-In, Zoom-Out, Pan, and Find Me) were blocked together as a one group of functions, and were covered first. The other functions were each treated separately, and were covered next in the following sequence: Find X, Pre-mission setup for Display, and Range/Azimuth.

Map Training Conditions

Each of the five map training conditions is described in this section. From learner-centric to instructor-centric, the conditions ordered as follows:

- Explore Only
- Explore via Exercises
- Lesson then Explore
- Lessons and Exercises

The fifth condition, Self-Select, did not fall directly on this continuum as Soldiers could use any combination of the above approaches in this condition.

Explore Only condition (explore map freely, coded as Expl Only in tables and figures). The Soldiers in the Explore Only condition explored the map on their own with minimal guidance and information. Soldiers had 60 minutes to work with the map. They were told which seven functions/buttons they had to learn (all seven map functions were operational at the same time), but not how the functions worked or the information they provided. That is, there were no instructions on how these functions or the map interface worked. When Soldiers thought they had mastered the functions, they could then exit the map interface and take the map final exam. The Soldiers in this condition had no external feedback on whether they fully understood all seven functions. They used their own judgment on when to proceed to the map final exam. This condition replicated the "pure" exploratory condition in the Dyer and Salter (2001) experiment.

Explore via Exercise condition (solve exercises by exploring the map, coded as Expl Exer in tables and figures). The Explore via Exercise condition was a guided exploratory

learning condition. Soldiers did not receive any formal instructions or lessons, but learned the map functions through practical exercises with performance feedback. Soldiers were presented a question, and then had five minutes to work with the map to solve the question. They were provided immediate corrective feedback on their performance on each question. The exercises were provided for all four groups of functions. Depending on the functions covered in the exercises, only the pertinent buttons/functions became operational (e.g., Zoom-In, Zoom-Out, Pan, and Find Me buttons for the first group of functions, Find X button for the second group, and so on). Thus only the applicable functions covered in a given topic were operational when Soldiers attempted to answer a question by exploring the map interface. At the end of this condition, Soldiers had the option to fully explore the digital map on their own before starting the map final. All functions were operational for this full exploration option.

Lesson then Explore condition (lesson then exploration of the map, coded as Lsn-Expl in the tables and figures). The Lesson then Explore condition was also a form of guided exploratory learning. This condition provided lessons for each of the four groups of functions, but no practical exercises. After completing each lesson, Soldiers were allowed to explore the map on their own for 15 minutes. Only the functions covered in the lesson were operational when they explored the map. Similar to the Explore via Exercise condition, at the end of all training, Soldiers had the option for full exploration of the digital map before they started the map final. All functions were operational for this full exploration option.

Lesson and Exercise condition (coded as Lsn-Exer in the tables and figures). The Lesson and Exercise condition was a common mode of instruction used in the Army and in most CBT. Soldiers received lessons on each of the groups of map functions. Immediately following each lesson, the Soldiers had practical exercises. They had five minutes to answer each question within an exercise. They received immediate feedback on each answer. If unable to answer within five minutes, they received a time-out message. As there were four groups of functions, the Soldiers had four sets of lessons with exercises. The lessons were the same as those under the Lesson then Explore condition. The exercises were the same as those in the Explore via Exercise condition. This condition replicated the low-memory demand map training condition in the Dyer and Salter (2001) experiment.

Self-select condition (choice of lesson, exercises, exploring map, or any combination of these modes, coded as Self-Select in the tables and figures). The Self-Select condition allowed the Soldiers to choose the training mode or modes they wanted to use. Within each of the four groups of functions, they could select whether to take the lesson, the practical exercises, and/or explore the map. In addition, they could select these options in any order and in any combination. What they selected for one set of map functions did not affect what they could select within the next set of map functions. The lessons were the same as those in the Lesson then Explore, and the Lesson and Exercise conditions. The exercises were the same as those in the Explore via Exercise, and the Lesson and Exercise conditions, but 15 minutes was allowed to answer a question. In addition, for map exploration, only the functions being trained were operational. This was not a traditional mode of training. However, it was an attempt to tailor training to the diverse population of Soldiers who will use the digital systems, and to determine what training strategy was selected by most Soldiers.

The instructions given to Soldiers for each map training condition are presented in Appendix A. This information presented the seven map functions they were to learn, what type of training they would receive and/or could choose, and how they were to progress through the entire map training.

Measurement Instruments

Background and Demographic Surveys

After completing the training, the Soldiers completed a survey on their computer background and experience, their general reactions to the symbol and map training, and their reaction to the specific map training condition which they had used (see Appendix B). As there were five map training conditions, the Soldiers assigned to the different conditions answered several questions that were tailored to their designated map condition.

For computer background and experience, the Soldiers completed a computer survey that had been given previously to more than 3000 Soldiers as a part of a multi-year research effort initiated in FY99 to examine Soldiers' experiences with computers (Dyer & Martin, 1999; Fober, Bredthauer, & Dyer, 2000, 2001; Singh & Dyer, 2001, 2002). This survey instrument is in Appendix B. The survey obtained the necessary demographic information from Soldiers. The computer-related questions were on the following topics:

- Where Soldiers used computers in their formal education.
- Where they currently use computers.
- Whether they owned a computer.
- How often they used specific computer features.
- Self-ratings of typing skill.
- Self-ratings of computer skill and the names of computer software/languages they use.
- An 18-item icon test of icons common to Windows-based software programs.

Soldiers also answered two other questions directed at their normal tendency to work independently (see Appendix B). The questions on tendency to work independently were developed by Dyer and Salter (2001) in an attempt to identify Soldiers who tend to figure things out on their own, and hence might be good in an exploratory learning environment. The same rationale was used in this research to examine whether the individuals who possessed a general tendency to solve problems on their own were superior in the Explore Only condition (i.e., condition with minimal guidance and information). First, they were asked if they already knew a way to perform a task on the computer, whether they usually figure out a shortcut that allows them to do the same computer task in fewer steps. Secondly, they were asked to rate the extent to which they have a "knack" for learning computer programs on their own and a tendency to figure out computer shortcuts.

Training survey. The training survey had some questions applicable to all Soldiers irrespective of their assigned map training condition (see Appendix B). Soldiers had to indicate whether the symbols or map training was harder, or if they were same in the difficulty. In addition, Soldiers were asked if their previous military training or their experience with

computers helped them during the symbol and map training. They were also asked if they had sufficient time to learn all the information.

As the symbol training was same for all Soldiers, the training questions were identical for all Soldiers. Soldiers indicated the symbol code that was easiest to learn, and the symbol code that was hardest to learn. The training survey also inquired about Soldiers' reaction to the "think-ahead" questions. These questions addressed if they tried to answer the think-ahead questions correctly, if they clicked on more than one think-ahead response, the difficulty of the think-ahead questions, and if they would retain the think-ahead questions as a training technique.

In addition to the common questions, specific questions addressed Soldiers' reactions to the map training they received (see Appendix B). Soldiers within each map condition had their own set of questions. However, the first three questions for all map training conditions were somewhat similar. Soldiers rank ordered the map functions from easiest to hardest to learn; indicated the effectiveness of their training, and indicated if they like the training they received. The other map training survey questions were tailored to the Soldiers' assigned map condition (for questions, see Appendix B). These questions focused on the following areas:

- Whether the Soldiers thought they would have benefited from a different mode of training than the one they had just received during the experiment. Some examples of these questions are as follows:
  - For the Soldiers assigned to the Explore Only condition, they were asked if formal instructions would have helped them.
  - When Soldiers were assigned to the Lesson and Exercise condition, they were asked if the opportunity to work with the map on their own would have helped.
  - For Soldiers in the Self-Select condition, they were asked which of the training methods they preferred. The options covered all combinations of the training modes: each alone, each in combination with one other mode, or all three modes.
- A free response question at the end allowed Soldiers to add written comments about the training they received.

Lastly, the IOBC Soldiers were asked what mode(s) of training they would prefer for sustainment training: reviewing lesson material, performing exercises with immediate feedback, or working with the map. They could check more than one mode.

Symbol and Map Final Exams

All questions on the symbol final exam were in a multiple-choice format, with 60 seconds allowed to respond to each question. The final exam had 24 questions. It required application of the concepts learned in the training, as the questions differed from those in the exercises. There was no immediate feedback after each question. Soldiers were presented with their final score. Examples of the symbol questions are in Figure C-1 (Appendix C).

The map exam required Soldiers to accomplish a variety of tasks such as displaying and locating individuals or units, zooming in or out, find oneself, locating points on the map, and determining range and azimuth. The exam had 21 items, with seven two-part questions, for a

total of 28 points. Tasks worth two points required Soldiers to perform two functions to complete the task. Soldiers had 60 seconds to complete each task. If they did not answer the question within 60 seconds, they were told they had timed out and they had to proceed to the next question. In addition, Soldiers were told that their last action on the map interface would be recorded as their final answer. There was no immediate feedback after each question. Soldiers were shown their final score.

Participants

Participants were Soldiers from two U.S. Army Infantry School courses, IOBC and OSUT at Fort Benning, GA. The Infantry OSUT Soldiers were in the 8th to 11th week of their training cycle, which is a 14- to 16-week course, depending on their Infantry military occupational specialty (MOS). All Infantry officers, regardless of commissioning source, had just graduated from the IOBC, a 16-week course.

The experimental design called for 72 Soldiers from each course. Of these Soldiers, 24 Soldiers from the each course were to be in the Self-Select experimental condition and 12 Soldiers from the each course were to participate in each of the other four experimental conditions. The Self-Select condition had more Soldiers in order to provide more reliable estimates of the modes of training Soldiers used and preferred.

Originally, there were 91 Soldiers from OSUT and 75 Soldiers from IOBC. However, due to computer malfunctions some Soldiers were not able to complete all of their tasks, and data were not saved for some other Soldiers. Consequently, incomplete data were discarded. The actual numbers of Soldiers whose data were used in the final analyses were 85 OSUT Soldiers and 67 IOBC Soldiers. The distribution of OSUT and IOBC Soldiers in the experimental training conditions for those who had complete data is depicted in Table 2. The number of IOBC Soldiers in the Self-Select condition was less than desired due to computer malfunctions.

Table 2
Number of Soldiers by Course in Each Experimental Condition

Course	***Map Training Condition***					
	Expl Only	**Expl Exer**	**Lsn-Expl**	**Lsn-Exer**	**Self-Select**	**Total**
OSUT	13	18	14	16	24	85
IOBC	13	13	14	14	13	67
Total	26	28	27	28	35	152

Note. Due to some minor computer malfunctions, the total sample size ranged from 144-152, depending on the measure of interest.

All IOBC Soldiers were college graduates, whereas only one OSUT Soldier was a college graduate. All IOBC Soldiers held the rank of 2nd lieutenant, whereas all infantry OSUT Soldiers held the rank of private. The mean ages of the two groups differed significantly, $F(1, 149) =$

72.14, $p < .0001$. The OSUT Soldiers were younger ($M = 20.51$, $SD = 3.24$) than the IOBC Soldiers ($M = 24.81$, $SD = 2.87$). Additional demographic data are in Appendix C.

Procedure

Soldiers from the two courses were randomly assigned to one of the five experimental training conditions. The experiment was executed four times, twice for each group of Soldiers. Two multimedia rooms in the U.S. Army Infantry School were used. One multimedia room had 18 computers and the other multimedia room had 24 computers, allowing a maximum of 42 Soldiers to participate at a given time. The experimental sessions were held on four days in order to train all Soldiers.

The multimedia software was loaded on these computers prior to the experiment. Half the Soldiers participated in the experiment in the morning, and the other half in the afternoon. Four hours were allowed for each experimental session. After each testing session, Soldiers were given the training surveys to assess their computer background and experience, and their reaction to different computer training conditions (Appendix B).

Before starting the experiment, Soldiers were briefed on the scope of the experiment, and the possible computer problems they might face during the experiment. They were encouraged to take a break after completing the symbol final exam and before beginning the map training. They could take other breaks if desired, but they were recommended to take these breaks only after an exercise or lesson was completed. Research personnel were available to answer questions and troubleshoot computer problems that occurred during the experiment.

Results

Computer Background

Computer Use

In general, the computer backgrounds of the Soldiers (see Appendix C) were similar to those of the Soldiers surveyed in prior research (Dyer & Martin, 1999; Fober et al., 2000., 2001; Singh & Dyer, 2001, 2002). Complete results on computer use are in Tables C-3 through C-9 in Appendix C. Table 3 shows the percentage of Soldiers who used a computer at some time in their formal schooling, the percentage who used a computer, and the percentage who owned a computer. Even though the percentages of Soldiers using computers and owing a computer were high, these percentages were higher for Soldiers in the IOBC course. These findings were consistent with previous surveys of OSUT and IOBC Soldiers (e.g., Singh & Dyer, 2001).

Indices of Computer Skill

The survey provided both subjective and objective indices of computer skill. The subjective index was the Soldier's self-rating of skill on a six-point scale from "novice" to "Bill Gates would hire me." The objective index was based on the icon test. The icon test presented a

scanned image of 18 common, Window-based, icons. Soldiers had to write-in the functions of the icon. Significant differences were found between the courses on both indices; self-rating, $F(1, 149) = 16.28, p < .001$; icon test, $F(1, 147) = 31.35, p < .0001$. For both indices, the IOBC Soldiers were higher than the OSUT Soldiers. Table 4 presents summary descriptive statistics on each index. Additional information is in Appendix C, Tables C-10 through C-12.

Table 3
Percentage of Soldiers Indicating Computer Ownership, Use of a Computer, and Computer Use During Formal Education

Course	% Owning a Computer[a]	% Currently Using a Computer[b]	% Used Computer During Formal Education
OSUT	63%	87%	94%
IOBC	88%	98%	99%

[a] Own $\chi^2 (1) = 12.44, p < .0001$
[b] Use $\chi^2 (1) = 6.85, p < .05$

Table 4
Descriptive Statistics on Computer Self-Ratings and Icon Scores

Course		Self Rating		Icon Score	
	N	*M*	*SD*	*M*	*SD*
OSUT	84	1.92	1.03	7.14	3.35
IOBC	67	2.63	1.12	10.21	3.29

With the self-ratings of skill, about 13% of the IOBC Soldiers indicated they could program in at least one language as compared to 5% of the OSUT Soldiers (Table C-10). Almost 66% of the IOBC Soldiers said they were good with either one or several software programs, as compared to 45% of the OSUT Soldiers. Only 19% of the IOBC Soldiers rated themselves as computer novices compared to 50% of the OSUT Soldiers.

At the individual level across all Soldiers, the subjective index correlated significantly with the objective index, $r = 0.51$. At the course level, there also was agreement between the objective and subjective indices. The IOBC Soldiers' self-ratings and icon scores were higher than the OSUT Soldiers. The IOBC Soldiers perceived themselves as having better computer skills, and also performed better on the icon test than the OSUT Soldiers.

Symbol Training Results

For the symbol training, the primary interest was in determining whether there were any differences between Soldiers in OSUT and IOBC. The criterion variables were scores on each of the exercises, final exam score, time to complete the training, and time to complete the final exam. As the five CBT methods were used during the map training only (after symbol training), no differences or interactions were expected for these training conditions on symbol scores.

Two-way analyses of variance (ANOVA) were conducted, course by map condition, on the scores and times (see Tables D-1 through D-3, in Appendix D). IOBC Soldiers scored significantly higher that the OSUT Soldiers on each exercise and the symbol exam. IOBC Soldiers also took less time to complete the training and the symbol exam. As the symbol training was the same for all Soldiers, the course differences suggest that the different backgrounds of the IOBC and the OSUT Soldiers (e.g., age, education, military training) were responsible for (or mediated) these differences.

Soldier Reactions to Symbol Training

Soldiers were queried on which symbol codes were the hardest and easiest to learn. Both groups of Soldiers agreed that the symbols for weapons (e.g., rifle, machine gun) were the easiest to learn (OSUT 84% and IOBC 85%) and codes for platoon and company leaders were the hardest to learn (OSUT 50% and IOBC 38%). These results are tabulated in Tables C-16 and C-17 in Appendix C.

The Soldiers also answered questions on their reaction to the "think-ahead" questions. Most OSUT and IOBC Soldiers' comments were very positive towards the think-ahead questions (Table 5). In fact, 93% of the Soldiers indicated that if they had to revise the symbol lessons, they would retain these questions. In addition, 74% Soldiers thought the think-ahead questions were about right in difficulty, neither too easy nor too difficult.

Table 5
Soldiers' Reactions to Think-Ahead Questions in the Symbol Lessons (Percent Soldiers)

Think-Ahead Questions		**OSUT**		**IOBC**		**Both Courses**	
		Yes	No	Yes	No	Yes	No
Tried to answer the question correctly		98%	2%	100%	0%	99%	1%
Clicked on more than one response		46%	54%	43%	57%	45%	55%
Retain the question in future		91%	9%	94%	6%	93%	7%
How difficult were the questions?	Too Easy	21%		25%		23%	
	Too Difficult	5%		0%		3%	
	About Right	74%		75%		74%	

Note. There were no significant differences between OSUT and IOBC for any of the questions.

Map Training Results

The primary interest with the map training was whether the map scores were affected by the training conditions or by the two Soldier samples. The criterion measures common to all training conditions were the map exam score, map training time, and map exam time. The map final exam was considered the most crucial criterion measure. Exercise scores were only available for three of the five conditions (i.e., Explore via Exercises, Lesson and Exercise, and Self-Select). Also of interest were the training strategies used by Soldiers in the Self-Select

condition, and Soldiers' reactions to their specific training condition. Results from the map exam are reported first.

Scores and Times on Map Final Exam

Exam scores. A two-way ANOVA (training condition by course) was conducted on the map exam score. There was a significant main effect for course, $F(1, 134) = 46.46, p < .0001$, with the IOBC Soldiers scoring higher than the OSUT Soldiers (see Table 6). There was also a significant main effect for training condition, $F(4, 134) = 5.59, p < .0001$. Comparisons (Bonferroni procedure) among the training conditions showed that the Exploration Only scores were significantly lower than the other four conditions.

Table 6
Means (Standard Deviations) for Map Exam Scores (% correct)

Course	Map Training Condition					
	Expl Only	**Expl Exer**	**Lsn-Expl**	**Lsn-Exer**	**Self-Select**	**Total**
OSUT	41.76 (12.58) $n = 13$	67.86 (17.88) $n = 16$	59.95 (20.07) $n = 14$	73.81 (9.79) $n = 15$	62.82 (19.55) $n = 22$	61.96 (19.27) $N = 80$
IOBC	74.73 (9.39) $n = 13$	78.87 (16.85) $n = 12$	80.77 (15.81) $n = 13$	81.87 (20.60) $n = 13$	82.69 (9.87) $n = 13$	79.80 (14.89) $n = 64$
Total	58.24 (20.02) $n = 26$	72.58 (18.00) $n = 28$	69.97 (20.71) $n = 27$	77.55 (15.97) $n = 28$	70.20 (19.11) $n = 35$	69.89 (19.54) $N = 144$

These two main effects on the map final exam score were qualified by a significant interaction, $F(4, 134) = 2.47, p < .048$. The interaction is illustrated in Figure 3. A post hoc comparison (Bonferroni) showed that IOBC scored significantly higher than OSUT in three of the five conditions: the Exploration Only, Lessons with Exploration, and the Self-Select conditions (see Table 6 and also the confidence intervals in Figure 3). There were no differences between IOBC and OSUT in the Explore via Exercises and Lessons and Exercises conditions. These were also the two conditions where OSUT Soldiers performed the best, although not significantly so (see Figure 3). Of relevance, is that these were the only two conditions where Soldiers had to perform interactive exercises with the map and where they received immediate performance feedback.

In addition, the comparisons showed that OSUT Soldiers in the Exploration Only condition scored lower than those in the other conditions (see Figure 3). There were no differences between the conditions for IOBC Soldiers.

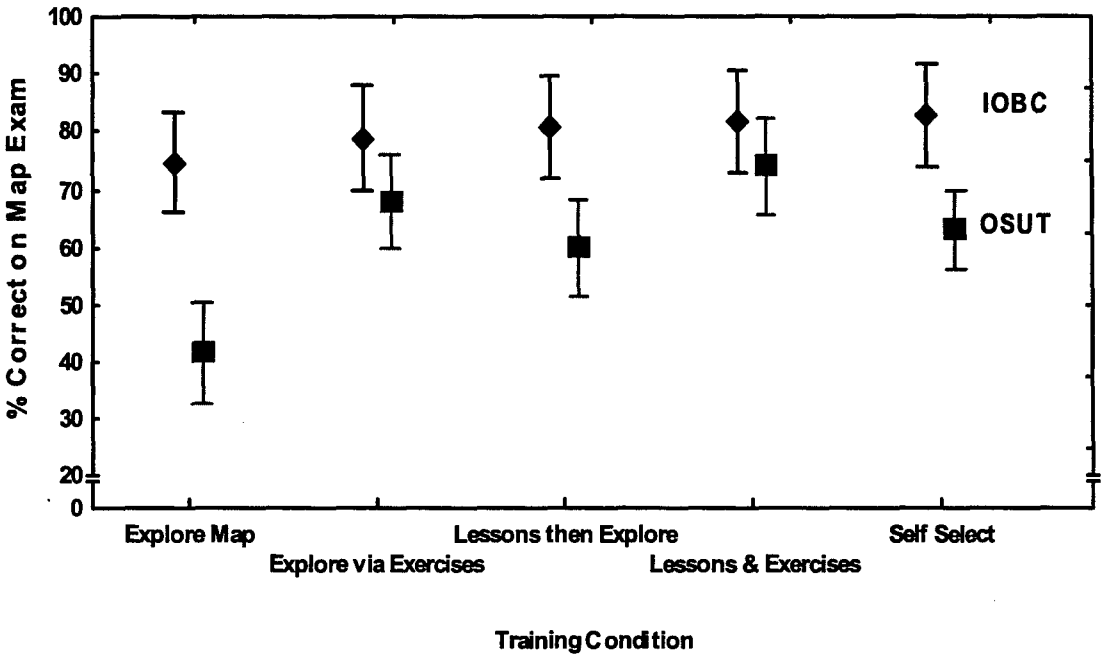


Figure 3. Map exam scores by course and map training condition. [Vertical bars denote 0.95 confidence intervals.]

The Exploration Only and the Lessons with Exercise training conditions replicated conditions in the Dyer and Salter (2001) experiment that used OSUT, BNCOC, ANCOC and IOBC Soldiers. The results in the current experiment coincide with those prior findings in that Soldiers in the Exploration Only condition had low scores and those in the Lesson and Exercise condition had high scores.

Exam times. A two-way ANOVA was also conducted on the map exam times. There was no significant main effect for course on the map final exam times, however, there was a significant main effect for condition, $F(4, 134) = 14.77, p < .0001$. Comparisons among conditions using the Bonferroni procedure showed that the Soldiers in the Explore via Exercise, Lesson and Exercise, and Self-Select conditions were significantly faster than the other two conditions of Explore Only and Lesson then Explore (14-15 min versus 18-19 min, see Table 7). There was no significant interaction on the map final exam times.

To put the map exam times into context, each item on the exam had a time limit of one minute. As there were 21 items, the maximum time a Soldier could spend on the map exam exercises was 21 minutes plus the time to read the questions. Thus Soldiers in the Explore via Exercises, Lessons and Exercises, and Self-Selection conditions, whose mean times ranged from 14 to 15 minutes, clearly took less time in reading and answering the questions than Soldiers in the Explore Only and Lessons then Explore conditions.

Table 7
Mean Time (standard deviations) to Complete Map Exam (in minutes and seconds)

Course	Map Training Condition					
	Expl Only	**Expl Exer**	**Lsn-Expl**	**Lsn-Exer**	**Self-Select**	**Total**
OSUT	19:37 (3:11) $n = 13$	13:32 (2:26) $n = 16$	19:08 (4:01) $n = 14$	14:33 (2:55) $n = 15$	15:12 (3:16) $n = 22$	16:09 (3:55) $n = 80$
IOBC	18:13 (3:47) $n = 13$	14:19 (2:18) $n = 12$	17:15 (3:06) $n = 13$	14:13 (2:52) $n = 13$	15:36 (1:46) $n = 13$	15:57 (3:12) $n = 64$
Both Courses	18:55 (3:30) $n = 26$	13:52 (2:22) $n = 28$	18:13 (3:40) $n = 27$	14:24 (2:51) $n = 28$	15:21 (2:47) $n = 35$	16:04 (3:36) $n = 144$

Map training times. Time to complete map training was also examined. An ANOVA was used to compare conditions and courses. On map training, IOBC was faster than OSUT (34 vs 41 min), $F(1, 138) = 8.09, p < .005$. In addition, Soldiers in Explore Only were significantly faster than those in each of the other conditions (8 min versus a mean of 44 min), $F(4, 138) = 74.98, p < .0001$. This training condition main effect was consistent with the Dyer and Salter (2001) research in that they found Soldiers spent little time exploring the map on their own, with the lessons and exercise modes of training taking four times longer than the exploratory mode. In the present experiment, the other modes averaged 5.5 times longer. There were no interaction effects. Means and standard deviations are in Table 8.

Table 8
Mean Time to Complete Map Training (in minutes and seconds)

Course	Map Training Condition					
	Expl Only	**Expl Exer**	**Lsn-Expl**	**Lsn-Exer**	**Self-Select**	**Total**
OSUT	8:11 (3:58) n =12	41:29 (14:01) n =17	36:55 (5:54) n =14	58:32 (7:21) n =15	49:55 (16:01) n =24	41:25 (19:16) n =82
IOBC	7:53 (4:43) n=13	32:46 (5:32) n =13	31:34 (7:08) n =13	53:20 (6:51) n =14	43:52 (17:34) n =13	34:11 (17:59) n =66
Both Courses	8:02 (4:17) n =25	37:42 (11:51) n =30	34:21 (6:57) n =27	56:01 (7:28) n =29	47:47 (16:35) n =37	38:11 (18:59) n =148

The time spent on lessons, exercises, and exploring the map for each group of map functions, for the appropriate training conditions, was also examined for trends. The Explore Only condition was not included in this comparison as the Soldiers examined all functions at one period of time, not separate periods.

For map lessons, Soldiers, regardless of training condition, spent about the same amount of time on each function. (See Appendix D, Table D-11. Typical times were 9:30 min for Display, 6:30 min for Zoom, 6 min for Find X, 3:30 min for Range-Azimuth.) For exercises, similar times occurred under the training conditions for all functions except for Display. Times were typically about 9 to 14 min for Display, 8 min for Zoom and for Find X, and 5 min for Range/Azimuth. Lastly, map exploration times were quite low for the two conditions where Soldiers could explore each function using the map (Lesson then Explore and Self-Select). Times were 2 min or less except for the 6 min on the Display function spent by the Soldiers in the Self-Select condition.

Of interest were two trends in these results. First, the total exercise time for the Explore via Exercise condition was higher than the other condition where everyone had exercises (Lesson and Exercise). This may be because using exercises was the only means of learning in the Explore via Exercise condition. Second, the times Soldiers spent exploring the map in the Lesson then Explore condition were minimal (1-2 min). Thus Soldiers in this condition used the lessons as the primary training mode, and did not work with the map to reinforce and/or verify the information in the lesson.

Relationship between map scores and times. The relationship between training times and exam scores is illustrated in Figure 4. For OSUT, the training times paralleled the exam scores; higher scores corresponded to longer training times. It should be noted that conditions that required the most time (Explore with Exercises and Lesson and Explore) were also the conditions where all Soldiers had to complete the exercises. For IOBC, the time spent in each condition followed the same pattern as for OSUT, but the times did not relate to performance, as scores were similar on all training conditions for IOBC. IOBC scores were all relatively high; reflecting a ceiling effect. If the map exam had been more difficult perhaps there would have been a relationship between time and scores.

Scores on Map Exercises

Scores on the map exercises were available in only three map training conditions: Explore via Exercises, Lessons and Exercises, and Self-Select (when a Soldier decided to use the exercises). Comparisons were made among these conditions on the four sets of exercises.

- Zoom in, zoom out, pan, and find me
- Locate individuals and units using the Find X function
- Pre-mission set-up for display
- Determine range and azimuth

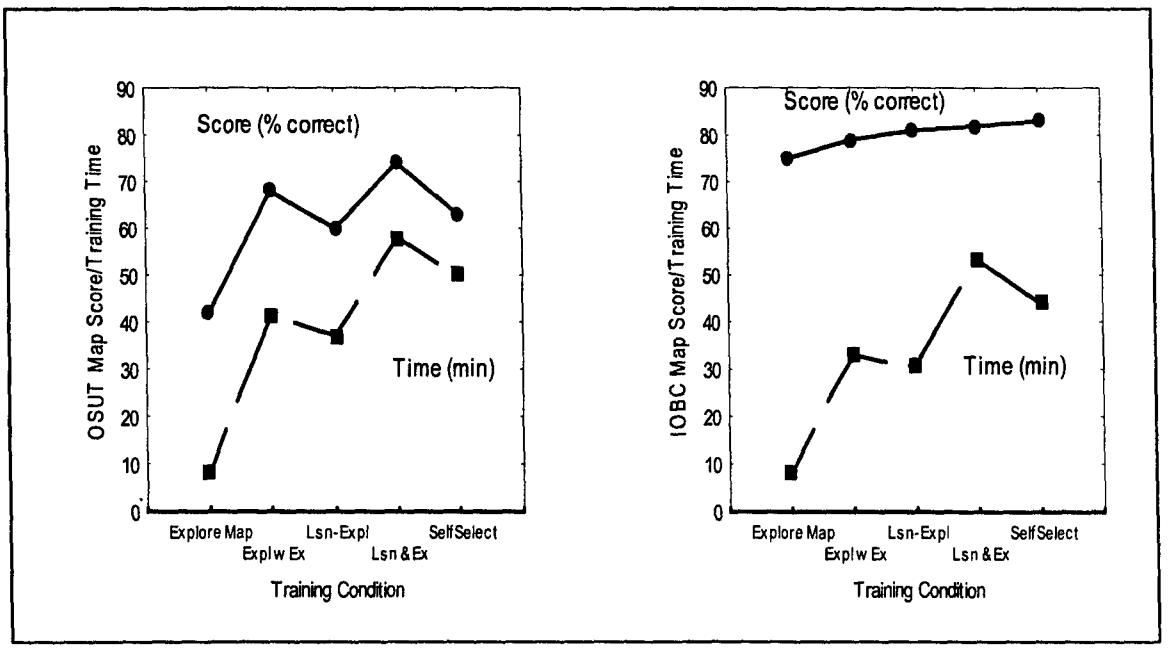


Figure 4. Map training times and exam scores.

In general, scores on the exercises were equivalent across the training conditions and the two courses. The only significant effect was on the score for Display, where IOBC Soldiers scored higher than OSUT Soldiers, $F(1,76)= 18.81, p < .001$ (see Table D-4, IOBC Soldiers scored 87% and OSUT Soldiers scored 60%).

Self-Select Learning Strategies

Given the limited prior research on the type of training in the Self-Select condition, we had no specific expectations regarding the modes of training Soldiers would select. One might anticipate that the Soldiers with better metacognitive strategies would perform better as they can self-regulate their own learning (see Hartley & Bendixen, 2001), but no measure of metacognitive or self-regulatory ability was used in the research. The actual choices made by the Soldiers for each map function group were examined to identify the strategies used by the IOBC and OSUT Soldiers.

The first question addressed was whether certain choice patterns were used more frequently than others. For example, did Soldiers typically take the lesson and then the exercise or did they just use exercises? All the possible Self-Select patterns of choice were identified and the frequency with which each was used by Soldiers in each course for each map function was tallied. The two most common patterns for both groups of Soldiers were lessons followed by exercises, and lessons only (see Table D-5). Together these two patterns accounted for 57% of all possible choices, with each pattern equally likely. The frequency of selecting the lesson-then-exercise pattern was consistent across the four sets of map functions for both groups of Soldiers.

This was also the case for use of the lesson only mode for IOBC. However, the frequency with which OSUT Soldiers selected the lesson only mode increased on the last two sets of map functions.

As a whole, the IOBC Soldiers' patterns of choice were less varied than was the case with the OSUT Soldiers (see Table D-5). For example, the IOBC Soldiers used only seven sequences, and the top three of these sequences accounted for 79% of all their choices. On the other hand, the OSUT Soldiers choices reflected a total of fourteen patterns, and the top three of these accounted for 43% of all choices.

Another analysis focused on the extent to which an individual Soldier was consistent in his selections and the sequence of his selections. Did a Soldier change his learning strategy as he progressed from one group of map functions to the next? Although the sample size was limited, the results showed some trends for consistent learning strategies to be more likely with the IOBC Soldiers than the OSUT Soldiers. Only five Soldiers used the same strategy each of the four times a selection could be made. All were from IOBC. Two used only lessons throughout; two used map exploration only, and one used exercises only (see Table D-6). Only one Soldier (from IOBC) used all three modes of training (although in varied sequences) throughout. This individual also had the highest map score (96%). These six Soldiers represented half of the IOBC sample ($n = 13$). There was only one OSUT Soldier (out of 24) who used the same modes of training throughout, although not in the same sequence over the four groups of map functions.

In addition, across all map functions, IOBC Soldiers were more likely than OSUT Soldiers to start a training session with exercises (81% versus 68%). Similar percentages from both groups selected all three modes of training for the first map function they had to learn (31% for IOBC; 38% for OSUT). But for these individuals, the OSUT Soldiers were less likely to choose a consistent pattern after this point than was the case for the IOBC Soldiers (see Table D-6).

Also examined was whether there was a relationship between patterns of choice (the Soldier's strategy) and map score. There was a tendency for those Soldiers who were consistent in their selections and who consistently took advantage of more than one mode of training to score higher, $\chi^2(2) = 13.17, p < .01$. This relationship is shown in Table 9. High map scores were defined as 80% correct or higher. Low map scores were those below 80% correct. Patterns of choices were placed in one of three categories. The first category included Soldiers who always selected all three modes of training, as well as those who always selected a combination of two or three modes across the four map function groupings. All Soldiers in this group had high scores. The second category included Soldiers who selected one mode as well as two modes. Half these Soldiers and high scores; and half had low scores. The third category represented Soldiers who used all other combinations of training modes; 87% had low scores.

Lastly, the frequency with which specific training combinations were selected was examined, regardless of the order of the selection. For example, for this comparison selecting a lesson then the exercise was not distinguished from selecting the exercise and then the lesson. This frequency was then compared to the Soldier preference rating which was obtained in the survey for the Self-Select condition. Table 10 shows these results.

Table 9
Self-Select Condition: Relationship Between Map Scores and Number/Pattern of Training Modes Selected

Number of Modes a Soldier Selected Across the Four Map Functions	Map Score	
	High >= 80%	Low <=79%
	# of Soldiers	
Most Consistent Selections: All three modes or a combination of 2 and 3 modes	5	0
Combination of one and two modes	6	6
Least Consistent Selections: All other combinations (e.g., only 1 mode, combination of 1, 2 and 3 modes)	2	14

Note. $n = 33$ (incomplete data on 4 OSUT Soldiers).

Table 10
Self-Select Condition: Comparison of Training Modes Selected and Stated Preferences

Training Mode and Mode Combinations	% Actual Occurrences / % Preferred		
	OSUT	IOBC	Both Courses
Lessons & Exercises	29 / 30	35 / 38	31 / 33
Lessons Only	27 / 30	31 / 23	28 / 28
All Three	15 / 9	15 / 8	15 / 8
Exercises Only	15 / 30	4 / 15	11 / 25
Explore Map Only	5 / 0	14 / 15	8 / 6
Lessons & Explore Map	5 / 0	2 / 0	4 / 0
Exercises & Explore Map	3 / 0	0 / 0	2 / 0

As mentioned previously, in terms of actual use, the most common training strategy was selecting both exercises and lessons followed by lessons only. In general, Soldiers' preferences agreed with their use of these two modes of training. For other modes of training, some differences did occur. All three training modes were used 15% of the time by both groups of Soldiers, in contrast to 8% of Soldiers who indicated this was a preferred strategy. For both IOBC and OSUT, use of Exercises Only was lower than the stated preference. Lastly, for Explore Map Only, more IOBC Soldiers used and preferred this mode of training than did OSUT Soldiers.

The results for the Soldiers in the Self-Select condition suggest that the IOBC Soldiers had better metacognitive skills and were more able to implement effective training strategies as compared to the OSUT Soldiers. This is reflected in higher map scores for IOBC on the Self-Select condition and by their more consistent strategy selections. The OSUT Soldiers' choices were more diverse and were more varied from one map function to the next. It could also be that IOBC Soldiers had a better understanding of what training modes worked well for them at the start of the experiment and simply employed this strategy or slight variations of it throughout.

Reactions to Map Training

The map training survey was tailored to the Soldiers' assigned map condition. However, the first three questions were somewhat similar in that they required Soldiers to rank order the difficulty of the map functions, assess the effectiveness of their training condition, and assess how much they liked their training. The IOBC and OSUT Soldiers ordered the four set of function from easy to hard the same. Zoom/Pan/Find Me was the easiest, followed by Range/Azimuth, then Display units/individuals, with Find units/individuals ranked as the most difficult. Descriptive statistics are in Table E-17 (Appendix E).

The two other common questions addressed whether the Soldiers thought the mode of training they had was effective and whether they liked it. The Soldiers' reaction to the map training reflected their performance. All OSUT Soldiers thought the Lesson and Exercise condition was effective and all liked it (see Table 11); and their map score was highest in this condition. All IOBC Soldiers rated the Self-Select condition as effective and all liked it (Table 11); and their performance was highest in this condition. On the other hand, the lowest percentages for effectiveness and positive reactions occurred for the Explore Only condition. This was the case for both OSUT and IOBC Soldiers, and their map scores were lowest in this condition as well.

Table 11
Percentage of Soldiers Indicating Their Map Training was Effective and They Liked it

Training Condition	**OSUT**		**IOBC**	
	Effective Training	Liked Training	Effective Training	Liked Training
Explore Only	46%	62%	77%	77%
Explore via Exercises	94%	89%	92%	77%
Lessons then Explore	100%	86%	79%	86%
Lessons and Exercises	100%	100%	100%	85%
Self-Select	87%	87%	100%	100%

Informal interviews with the OSUT Soldiers provided some insights into the diversity within this particular target population. One Soldier in the Explore Only condition stated he performed better when he had feedback on how he was doing (there was no feedback in this condition). Another OSUT soldier in this condition indicated that he could not figure out what to do and was frustrated. He proceeded to the map exam quickly and did not spend time trying to understand the functions by working with the map.

In the Self-Select condition, the researchers had to spend considerable time with one Soldier to help him understand what he could do; that he could select the modes of training he preferred; he could use his own strategy. This Soldier did not perform well on the map exam. On the other hand, another Soldier in the Self-Select condition queried the researchers to clarify what he was to do, understood it quickly and immediately reacted with the statement "That's cool." He was the top performer in this condition.

Soldiers were asked if different forms of training than the one they received would have been beneficial. For example, the Soldiers in the Explore Only condition were asked if formal instructions and map exercises would have helped them to understand the map functions better. Typically, Soldiers in each of the conditions indicated that some other modes of training would have helped as well (see Tables E-2, E-4, E-7, and E-11). The highest percentages regarding other modes of training were in the Exploration Only condition, where Soldiers indicated both lessons and exercises with feedback would have helped (Table E-2); and the Lesson with Exploration condition, where Soldiers indicated exercises with feedback would have helped (Table E-7).

Sustainment Training

The IOBC Soldiers were asked which modes of training they would prefer for sustaining their skills. The choices were reviewing lessons, exercises with feedback, and working with the map, but they could select more than one mode. Exercises Only accounted for 39% of the responses; exercises and using the map for 21%, and all three modes (lesson, exercise and map) accounted for another 14% of the responses (see Table E-15). Considering all possible single and multiple options, sustaining knowledge and skills through exercises with feedback was the most frequently preferred technique, while reviewing lessons was the least preferred. There was no expectation regarding how Soldiers would answer this question, but hindsight would suggest that Soldiers assumed there was more of a need to refresh skills by actually performing or executing tasks, as opposing to reading information about them.

Map Correlations with Background Variables

The measures of computer knowledge (based on the icon test score) and tendency to work independently (i.e., shortcuts to solve computer tasks and knack for learning computers) were correlated with the map final exam. The correlations were examined for each training condition, in that it was important to determine whether the tendency to work independently related to map scores in the Self-Select condition. The only significant correlation for the work independently measures was between the shortcut index and map exam for the Explore Only condition ($r = .44$, see Table D-10). Computer knowledge correlated with the map score under three conditions (Explore Only, Explore via Exercise, and Lesson then Explore, $r = .48$, .48, and .38 respectively).

General Reactions to the Map and Symbol Training

Soldiers were given general questions that pertained to both the symbols and the map training. The first question focused on which content was more difficult, symbols or map

functions. Over half (55%) of the Soldiers indicated the map training was harder than the symbol training; 37% found both to be of similar difficulty (see Table C-14). Only 7%, primarily OSUT Soldiers, indicated that the symbol training was harder than the map training.

Previous military experience and previous computer experience were perceived as more likely to help by the IOBC Soldiers than the OSUT Soldiers; 90% versus 56% respectively for military experience, and 78% versus 58% respectively for computer experience. It should be noted that the primary military experience for the OSUT Soldiers was limited to OSUT itself, which does not stress many of the topics covered in the symbol and map training. In addition, a high percentage of the Soldiers in each course (at least 83%) indicated they had sufficient time to learn the tasks (see Table C-14).

Discussion

Symbol Training

Because the symbol training was the same for all Soldiers, and Soldiers were randomly assigned to the map training conditions, no differences were expected on symbol scores as a function of map training condition. This proved to be the case. However, as in Dyer and Salter (2001), IOBC Soldiers scored higher and completed the training in less time than did the OSUT Soldiers.

Of interest was the reaction to the "think-ahead" questions inserted in the symbol training. Overall, the reaction was quite positive by Soldiers in both courses. They indicated they liked the questions and would recommend including them in revisions of the symbol training. This technique may have general applicability as a means of enabling Soldiers to think about the lesson material within a CBT format where they are primarily recipients of information. It is a way to encourage them to reflect on the content, to be active rather than passive in this training mode.

Map Training

The map findings showed that different forms of training worked better for some Soldiers than for others, although the impact was greatest with the OSUT Soldiers, who were the youngest and those with the least Army experience. The IOBC Soldiers' scores were higher than the OSUT Soldiers for each condition, although under two training conditions OSUT performance did not differ significantly from IOBC. The training strategies employed by the OSUT and IOBC Soldiers differed in the Self-Select training condition, with IOBC being more consistent in their training strategies. In-depth analyses of the performance data and the survey data revealed additional relationships that warrant consideration in designing CBT for Soldiers.

How did the Training Work for Different Soldiers?

Lessons and exercises on map functions. This traditional training condition was effective for both groups of Soldiers. The high performance was consistent with Dyer and Salter

(2001). The finding could reflect the familiarity Soldiers have with this approach; lessons with exercises is a common mode of training in the Army. Soldiers had to complete exercises that incorporated performance feedback. The most time was spent in this condition by both groups of Soldiers as both lessons and exercises were required. It is also a sound training technique.

OSUT Soldiers performed highest in this condition, what Clark and Wittrock (2000) categorized as behavioral – learning by rule, example, practice and feedback. All OSUT Soldiers liked this approach and thought it was effective. It is instructor-centric, not learner-centric.

Exploring the map functions with structured exercises, no lessons. Again both groups did well under this condition. But the OSUT Soldier results are interesting, given the differential impact the training conditions had on their performance. The OSUT Soldiers performed almost as high in the Explore via Exercise condition (a guided-exploratory condition) as they did in the Lesson and Exercise condition, despite spending less time training in this condition. The Explore via Exercise condition did incorporate a problem-solving approach; it was learner-centric but incorporated performance feedback, and Soldiers were active participants in the learning process. All these factors are consistent with the Schaab et al. (2004) results and the effectiveness of other guided discovery, problem-solving approaches.

Map lesson followed by exploring the map, no exercises. Although the Lesson then Explore condition was categorized as a guided exploratory condition when the experiment was designed, the training time data during the map exploration phases indicate that it corresponded to Clark and Wittrock's (2000) receptive category (teaching by telling) instead. For each group of map functions, Soldiers under this condition spent 2 minutes or less working with the map on their own. Thus they really did not use this opportunity to guide them to "test" or "check" what they had been told in the lesson, nor use the opportunity to work extensively with the map. The bulk of their time was on the lessons, which placed them in an instructor-centric, not a learner-centric mode. The lack of an opportunity to formally apply what was in the lessons appeared to have a negative impact effect on OSUT Soldiers, but not those in IOBC.

Unguided exploration of the map with no lessons and no exercises. For both groups of Soldiers, the Explore Only training condition was the least effective, although not significantly different from other conditions for the IOBC Soldiers. Both groups of Soldiers also spent the least amount of time training with this approach. OSUT Soldiers, in particular, did not perform well in this condition. These performance results replicated the Dyer and Salter (2001) findings, and are consistent with much of the research literature that has examined similar "pure" exploratory or discovery training conditions. Explore Only was also the least preferred training approach in that the percentages of Soldiers who thought it was effective and liked it were the lowest of all the training conditions. The poor performance associated with this form of training is often attributed to the demands placed on learners' metacognitive skills, the difficulty in knowing when tasks are performed correctly or most efficiently (no performance feedback), the inability to know what one does not know, and poor search or exploration strategies. Although Schaab et al. (2004) reported that Soldiers preferred to learn a software package through exploring it, this experiment and the prior Dyer and Salter (2001) experiment indicate that letting

young Soldiers learn the digital interface for a tactical system on their own is not the best training strategy.

One could argue that the results for the Explore Only condition, where IOBC Soldiers scored higher than OSUT, reflected differences in ability, and therefore are consistent with some of the prior research that has examined effects of training as a function of individual differences (e.g., Charney, et al., 1990; Riser et al., al, 1998). No data on "ability" were available to examine this hypothesis. However, it would be premature to conclude that the two groups of Soldiers differed on ability, as they also differed in age, educational experience, and military knowledge, each of which could impact their performance and reaction to this particular training condition. About 40% of the IOBC Soldiers were commissioned through the Officer Candidate School and therefore had prior military experience as enlisted personnel. And obviously, the IOBC Soldiers had more formal educational experiences.

Selecting an individual training strategy from lessons, exercises, and exploration options. Hartley and Bendixon (2001), when examining training approaches using media typical of the information age (world-wide-web, e-mail, collaborative tools, information searches), stated it was important to better understand how learner characteristics affect an individual's ability to succeed in training environments that vary from traditional approaches. In particular Hartley and Bendixon indicated that Internet approaches may set some individuals up for failure, as they may not possess the self-regulatory skills required in this environment. Although the Self-Select condition in the current experiment did not leverage Internet approaches to training, it was a non-traditional mode of training for Soldiers. The analyses of the learning strategies used by Soldiers in this condition provided insights into their performance, and the advantage and disadvantages of this approach.

In the Self-Select condition, the IOBC Soldiers scored significantly higher than OSUT Soldiers, and employed different training strategies. IOBC Soldiers were more consistent, less diverse, in their selections of training modes as they progressed from one group of map functions to the next than the OSUT Soldiers. For example, three training strategies accounted for 79% of all IOBC choices. On the other hand, the top three strategies used by OSUT Soldiers accounted for only 43% of all their choices. Across all map functions IOBC Soldiers were more likely to start a training strategy with exercises and to choose a consistent pattern after this point. Thus the IOBC Soldiers showed more self-regulatory skill by staying with the training modes that worked for them, whereas the OSUT Soldiers' choices were diverse and less consistent with regard to training modes.

The results are consistent with the argument that the OSUT Soldiers lacked the requisite metacognitive skills to take advantage of the Self-Select training condition. As a whole, their performance in this condition suggested that they did not know what types of training worked best for them, and were unable to identify these strategies during the training process. The results indicate that the OSUT Soldiers required a more structured format or guidelines regarding appropriate strategies to use.

Several reasons are offered here for the IOBC Soldiers' performance and selection of training strategies in the Self-Select condition. It could be that the IOBC Soldiers had a good

understanding of the training approaches that had succeeded for them in their prior pre-commissioning educational experiences, and simply employed these strategies throughout. But the findings also suggest that the IOBC Soldiers possessed superior metacognitive knowledge which accounted, in part, for their ability to select training strategies that led to better performance. The Self-Select condition may have motivated them as they had some degree of control over how they would be trained. They could choose among three options and combination of options, rather than being presented with only one option. All IOBC Soldiers said that the Self-Select training condition was effective and they liked it. This is consistent with Kanfer and McCombs' (2000) position that when individuals perceive themselves as having some control over their learning and also have the necessary metacognitive skills, their performance is higher. Future research should further investigate what training modes work best for this target population and why.

Implications for different target populations. For the IOBC Soldiers, the similarity in the map scores does not present a strong argument for one training condition over another. However, the training conditions that produced the two highest scores (Self-Select, and the Lesson and Exercise combination) were also the conditions they preferred the most. All IOBC Soldiers stated Self-Select was effective and that they liked it. The Self-Select training strategy results indicated that they understood what strategies would work well for them. With regard to the Lesson and Exercise condition, all said it was effective training while most said they liked it. Another factor with the IOBC Soldiers was the apparent ceiling effect on the final exam. A harder exam might have revealed differential effects for the different training conditions, and consequently the important training dimensions for this target population – the importance of exercises, the role of feedback, the role of learner control, etc.

With regard to OSUT Soldiers, the map scores did differ. In addition, it appeared that the OSUT Soldiers preferred an instructor-centered mode of instruction, and/or one where they could get feedback on their performance, whereas a segment of the IOBC Soldiers felt they could learn well under highly learner-centric conditions.

The five training conditions examined in the experiment were characterized along several dimensions. These were: Clark and Wittrock's (2000) four categories, the instruction to learner-centric dimension, whether Soldiers had access to information on the functions, the existence of performance feedback, and Soldier performance. This cross-tabulation is shown in Table 12. OSUT Soldiers performed highest in conditions where they had performance feedback in the context of tactical problems. Performance was high when also presented with information on the map functions. IOBC Soldiers did well in conditions where they were or could be presented with information on the map functions regardless of whether they applied the information to tactical problems.

Sustaining Skills

The consensus from the IOBC Soldiers was that exercises with feedback only, or combining exercises and working with the map were the preferred approaches to sustaining their skills. Refreshing skills by reviewing written material was not preferred. This preference for a

hands-on approach to sustaining skills is consistent with Soldier responses as reported by Schaab et al. (2004).

Table 12
Relationships Among Training Conditions, Training Dimensions, and Soldier Performance

Training Condition	Clark and Wittrock Category	Instruction vs Learner Centric	Performance Feedback	Content Presented	Soldier Performance (Rank Order)	
					IOBC	OSUT
• Lesson then Explore	Receptive	Instructor	No	Yes	3	4
• Lesson and Exercise	Behavioral	Instructor	Yes	Yes	2	1 High
• Explore via Exercise	Guided Discovery	Learner	Yes	No	4	2
• Self-Select	"Not applicable"	Learner	If exercises selected	If lessons selected	1 High	3
• Explore Only	Exploratory	Learner	No	No	5 Low	5 Low

Conclusions

The results do not support the often-heard claim that Soldiers can figure out a digital or software interface on their own. It appeared that the OSUT Soldiers needed more structure and performance feedback than the IOBC Soldiers, although there was more than one means that was successful in providing this structure and feedback. As seen from this experiment, careful thought should be given to CBT design to account for individual differences and to maximize learning on the part of all.

But what are these critical individual differences? Can we design more appropriate CBT on the basis of general demographic characteristics as opposed to extensive tests of Soldiers ability profiles? The current experiment simply categorized Soldiers according to course (corresponding to duty position – platoon leaders (IOBC) and riflemen (OSUT)), which in turn is associated with certain demographic characteristics. This approach is not as precise as a battery of tests, but is a practical solution when developing training programs for the Army.

One benefit of the CBT approach for the military is the flexibility it offers. It can be available when instructors are not, and when Soldiers cannot appear simultaneously for training. Furthermore, it allows for self-pacing of training. The variations of CBT implemented in the experiment demonstrated that CBT could be used for more than the traditional lesson-with-exercise approach. The problem-solving, CBT guided exploratory approach was successful, even though such exploratory training techniques are more traditionally implemented with an

instructor or tutor. In addition, a flexible training strategy was implemented successfully, that allowed individuals some control or choice over how they learned. But the results also indicated a need for more research on how CBT can be tailored effectively to Soldiers with different background and experience.

Further research is needed on modifications to the Self-Select mode used in the experiment. The findings support the need to tailor training to the background, experience and learning maturity of the Soldiers. An approach similar to the Self-Select mode could provide a cost-effective means of doing this as only one software program would be needed. In order to assist those Soldiers who lack the requisite metacognitive skills, instructional guidance could be embedded in the CBT program for Soldiers to select lessons and exercises, if they are not sure which training strategy works best for them or if the material is very new to them. Retaining the option of having Soldiers choose their training mode(s) would allow the more mature learners to have control over their learning strategy and to tailor their training in accordance with how they have succeeded in the past, thereby enhancing their motivation without lowering final performance levels.

The military context that served as the background for this experiment – a diverse population of Soldiers in various ranks and duty positions learning the same skills – is not unusual for the digital systems being fielded and that currently exist in the Army. However, this training context differs from the more traditional situation where Soldiers in different duty positions and ranks must acquire different skills. The findings reinforce the need to break from tradition, and to tailor training to Soldiers when the target population is diverse, and common skills and knowledge are required. Giving the same training to all is not the most efficient, nor the most effective, nor the most motivating. Effective computer-based-instruction should be flexible; should be able to combine and blend different training modes. The results of this research provide insights in how to develop such strategies for the successful acquisition of digital skills.

References

Ausubel, D. P. (1963). *The psychology of meaningful verbal learning: An introduction to school learning.* NY: Grune and Stratton.

Briggs, P. (1990). Do they know what they are doing? An evaluation of word-processor users' implicit and explicit task-relevant knowledge, and its role in self-directed learning. *International Journal of Man-Machine Studies, 32*, 385-398.

Carroll, J. M. (1997). Toward minimalist training: Supporting the sense-making activities of computer users. In M. A. Quinones & A. Ehrenstein (Eds.), *Training for a rapidly changing workplace* (pp. 303-327). Washington, DC: American Psychological Association.

Charney, D., Reder, L, & Kusbit, G. W. (1990). Goal setting and procedure selection in acquiring computer skills: A comparison of tutorials, problem solving, and learner exploration. *Cognition and Instruction, 7*, 323-342.

Clark, R., & Wittrock, M. C. (2000). Psychological principles in training. In S. Tobias & J. D. Fletcher (Eds.) *Training and retraining: A handbook for business, industry, government and the military* (pp. 51-84). New York: Macmillan.

Debowski, S., Wood, R. E., & Bandura, A. (2001). Impact of guided exploration and enactive exploration on self-regulatory mechanisms and information acquisition through electronic search. *Journal of Applied Psychology, 36*, 1129-1141.

DeMul, S., & Van Oostendrop. H. (1996). Learning user interfaces by exploration. *Acta Psychologica, 91*, 325-344.

Department of the Army. (1994, 9 September). *Personnel doctrine* (FM 12-6). Washington, DC: Author.

Department of the Army. (1997, 30 September). *Operational terms and graphics* (FM 101-5-1; MCRP 5-2A). Washington, DC: Author.

Dyer, J. L., & Martin, G. H. (1999). *The computer background of Infantrymen: FY99* (Research Report 1751). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A372 716)

Dyer, J.L., & Salter, R.S. (2001). *Working memory and exploration in training the knowledge and skills required by digital systems* (Research Report 1783). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A399 507)

Egan, D. E., & Greeno, J. G. (1973). Acquiring cognitive structures by discovery and rule learning. *Journal of Educational Psychology, 64*, 85-97.

Fletcher. J.D. (2003). Evidence for learning from technology-assisted instruction. In H. F. O'Neil & R S. Perez (Eds). *Technology Applications in Education* (pp. 79-99). Mahwah, NJ: Erlbaum.

Fober, G. W., Bredthauer, J. L., & Dyer, J. L. (2000). *The computer background of Soldiers in Infantry courses: FY99-00* (Research Report 1762). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A838 507)

Fober, G. W., Bredthauer, J. L., & Dyer, J. L. (2001). *Computer background of Soldiers in Army Units: FY-00* (Research Report 1778). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A399 393)

Gibbons, A. S., & Fairweather, P. G. (2000). Computer-based instruction. In S. Tobias & J. D. Fletcher (Eds.) *Training and retraining: A handbook for business, industry, government and the military* (pp. 410 -442). New York: Macmillan.

Gist, M. E., Schwoerer, C., & Rosen, B. (1989). Effects of alternative training methods on self-efficacy and performance in computer software training. *Journal of Applied Psychology, 74*, 884-891.

Hartley, K., & Bendixen, L.D. (2001). Educational research in the Internet age: Examining the role of individual characteristics. *Educational Researcher, 30(9)*, 22-26.

Kalyuga, S., Chandler, P., & Sweller, J. (2000). Incorporating learner experience into the design of multimedia instruction. *Journal of Educational Psychology, 92*, 126-136.

Kamouri, A. L., Kamouri, J., & Smith, K. H. (1986). Training by exploration: Facilitating transfer of procedural knowledge through analogical reasoning. *International Journal of Man-Machine Studies, 24*, 171 -192.

Kanfer, R., & McCombs, B. L. (2000). Motivation: Applying current theory to critical issues in training. In S. Tobias & J. D. Fletcher (Eds.) *Training and retraining: A handbook for business, industry, government and the military* (pp. 85 -108). New York: Macmillan.

Payne. S. J. & Howes, A. (1992). A task-action trace for exploratory learners. *Behaviour and Information Technology, 11*, 63-70.

Reiser, B. J., Copen, W. A., Ranney, M., Hamid, A., & Kimberg, D. Y. (1998). *Cognitive and motivational consequences of tutoring and discovery learning* (ARI Research Note 98-12). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No AD A-347 269)

Schaab, B. B., Dressel, J. D., & Moses, F. L. (2004). *Digital skills training for net-centric operations* (Special Report 58). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No AD A-421 861)

Shute, V. J., Lajoie, S. P., & Cluck, K. A. (2000). Individualized and group approaches to training. In S. Tobias & J. D. Fletcher (Eds.), *Training and retraining: A handbook for business, industry, government and the military* (pp. 171-207). New York: Macmillan Reference.

Singh, H., & Dyer, J.L. (2001). *The computer background of Soldiers in Infantry courses: FY01* (Research Report 1784). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A399 394)

Singh, H., & Dyer, J.L. (2002). *The computer background of Soldiers in Army units: FY01* (Research Report 1799). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (DTIC No. AD-A409 024)

Trudel, C. I., & Payne, S. J. (1995). Reflection and goal management in exploratory learning. *International Journal of Human-Computer Studies, 42,* 307-339.

Van Oostendorp, H., & De Mul, S. (1999). Learning by exploration: Thinking aloud while exploration an information system. *Instructional Science, 27,* 269-284.

Wallace, R. M., Kupperman, J., Krajcik, K. J., & Soloway, E. (2000). Science on the web: Students online in a sixth-grade classroom. *The Journal of Learning Sciences, 9,* 75-104.

Appendix A

Symbol and Map Training

Individual and Unit Symbol Codes

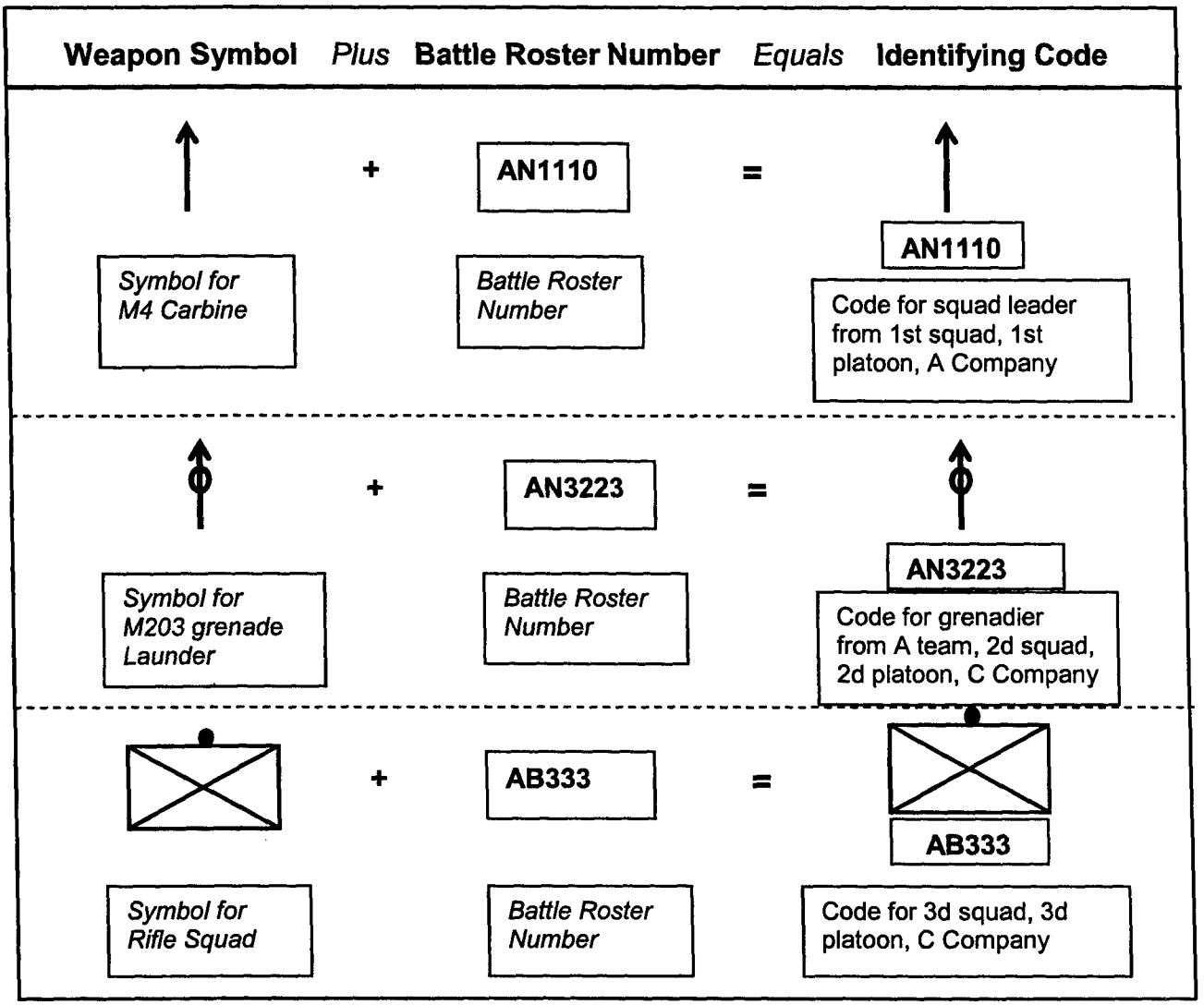


Figure A-1. Examples of individual and unit codes resulting from combining symbols with the battle roster numbering system.
Note. From *Working Memory and Exploration in Training the Knowledge and Skills Required by Digital Systems* (p. 13), by J.L. Dyer & R.S. Salter, 2001, Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. Adapted with permission.

Three codes are shown in Figure A-1: squad leader from 1st squad 1st platoon of A Company; grenadier from A fire team 2nd squad 2nd platoon of C Company; and unit code for 3rd squad 3rd platoon of C Company. For individual positions, the weapon symbol used by the individual in that position is combined with the battle roster number (Department of the Army [DA], 1994) for that position. For units, the standard unit symbol (for squad, platoon or company) was combined with a battle roster number that was truncated at the appropriate unit

level (e.g., squad, platoon or company). The battle roster (BR) number is an alphanumeric code with five positions. The first two letters designate the battalion, the 1st number the company, the 2nd number the platoon, the 3rd number the squad, and the 4th and last number the individual position within the squad. As illustrated in Figure 1, the symbol for the squad leader is the rifle symbol combined with a BR number of "AN1110" placed at the bottom of the rifle symbol. "AN" designates the battalion, the 1st "one" designates A Company, the 2nd "one" designates the first platoon, the 3rd "one" designates the first squad, and the last number of zero represents a leader.

Summary of Symbol Lessons

Weapon and unit symbols. Five weapon symbols (M4 carbine, M203 grenade launcher, M249 SAW (squad automatic weapon), M240B machine gun, and Javelin antitank weapon) and four unit symbols (unit, company, platoon, and squad) were presented. Except for the M249 SAW, all symbols were the same as those in the doctrinal manual on symbols FM 101-5-1 (DA, 1997). As there is no unique symbol for the SAW; a symbol was generated by Dyer and Salter (2001), which was also used in the present research. Soldiers were told this was not an approved Army symbol, and was used strictly for the instruction they were receiving.

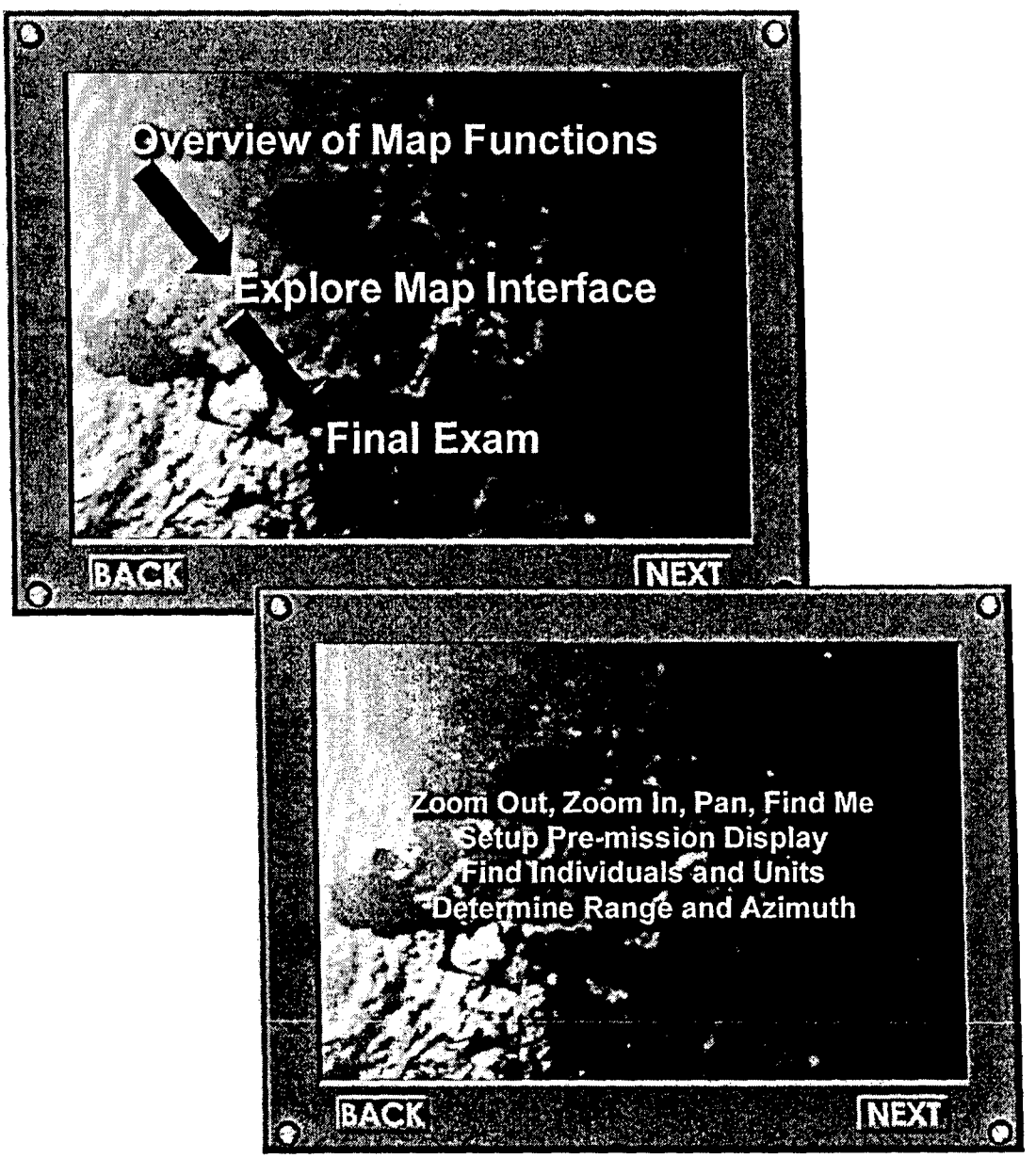
Battle roster numbering system. The concept of the battle roster numbering system was presented with an explanation of the five positions that uniquely defined individual duty positions.

Rifle squad. The numbers assigned to individuals within a rifle squad (0-8) were presented and defined. These individuals were divided by fire teams as well. At this point, the weapon symbol was combined with the BR number, as shown in Figure A-1.

Key leaders and units. The codes for three key leaders at both the company and platoon levels were presented. These were the company commander, executive officer, first sergeant, platoon leader, platoon sergeant, and radio-telephone operator. The weapon symbol for these duty positions (M4 carbine) was combined with the BR number. This final lesson also focused on codes for units, specifically the rifle company, platoon, and squad. The official symbols for each of these types of units were explained. For purposes of the training in the Dyer and Salter (2001) experiment, the BR number was truncated at the appropriate unit position. For example, the squad battle roster number omitted the individual position (the last number).

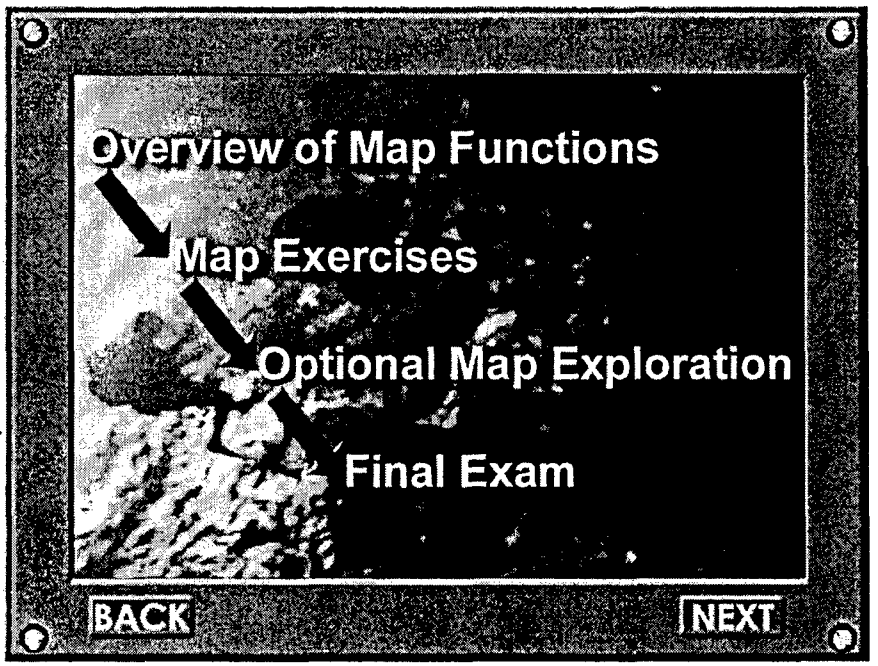
Screen Shots of Instructions for the Different Map Training Conditions

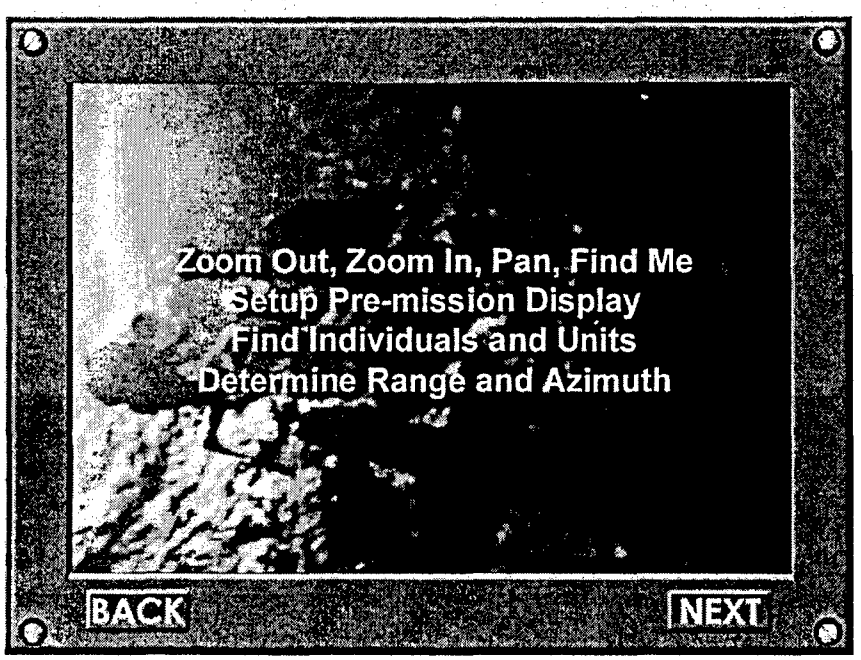
Explore Map Only Condition



The first slide shows the sequence of training. The second presents the map functions that are two be learned. Each line on the slide represents a different set of map functions for a set of four groups of functions.

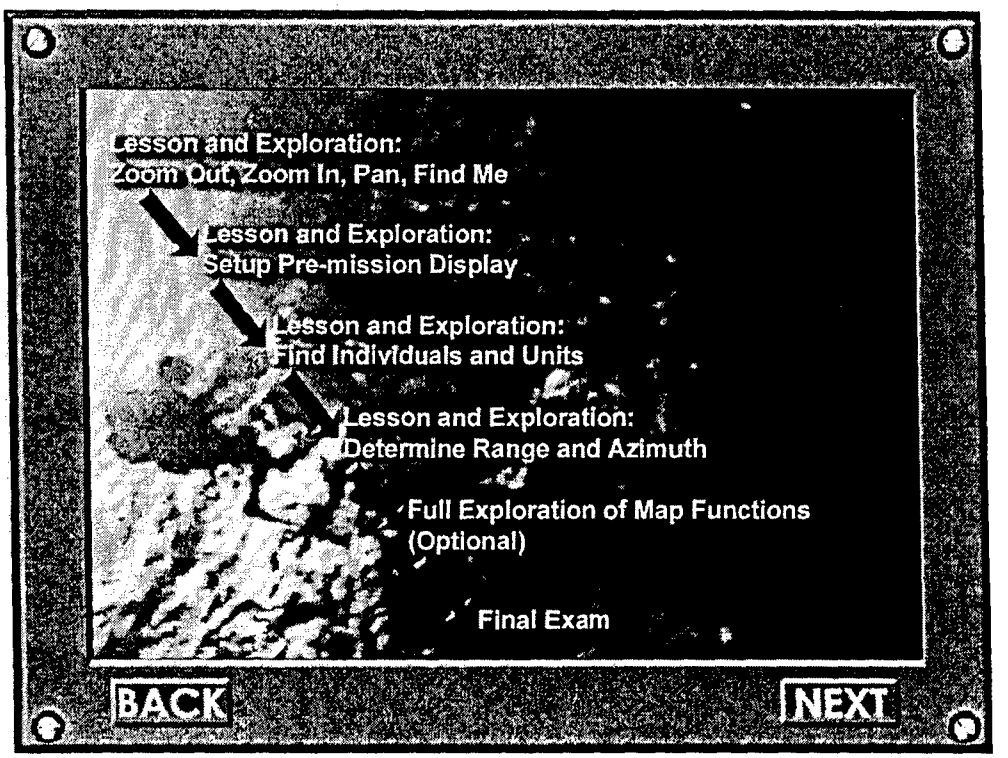
Explore Exercises Condition





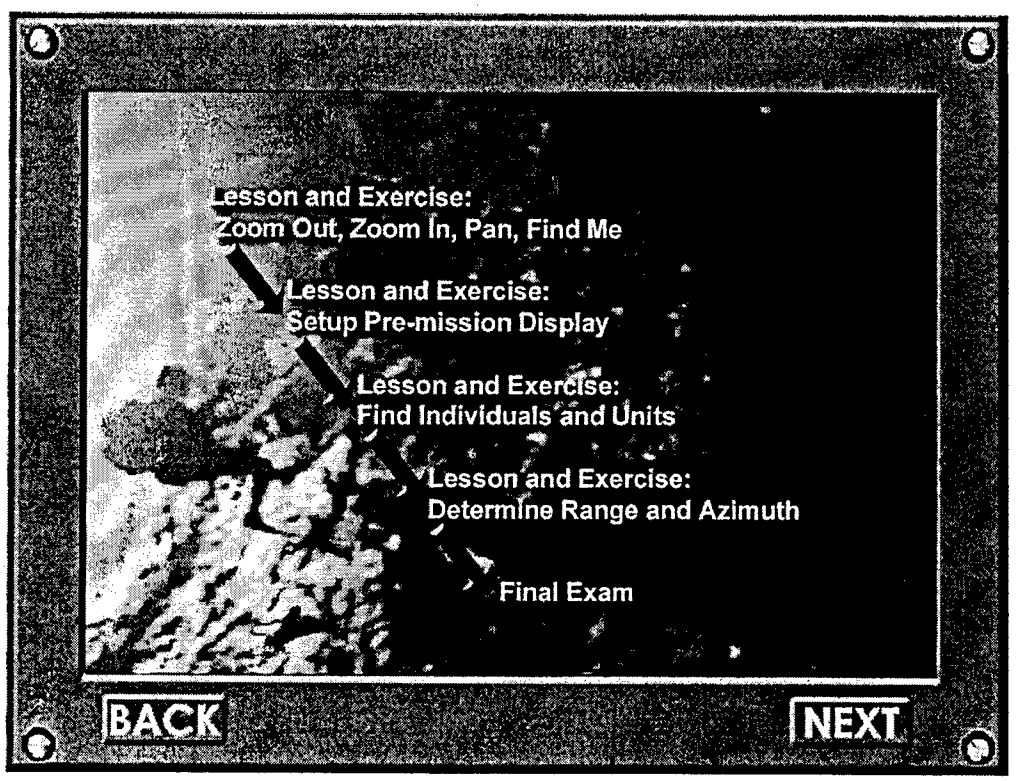
The first slide shows the sequence of training (Map Exercises and then Full Exploration). The second presents the map functions that are two be learned.

Lessons with Exploration Condition



Single instruction screen for Lessons with Exploration after each set of map functions.

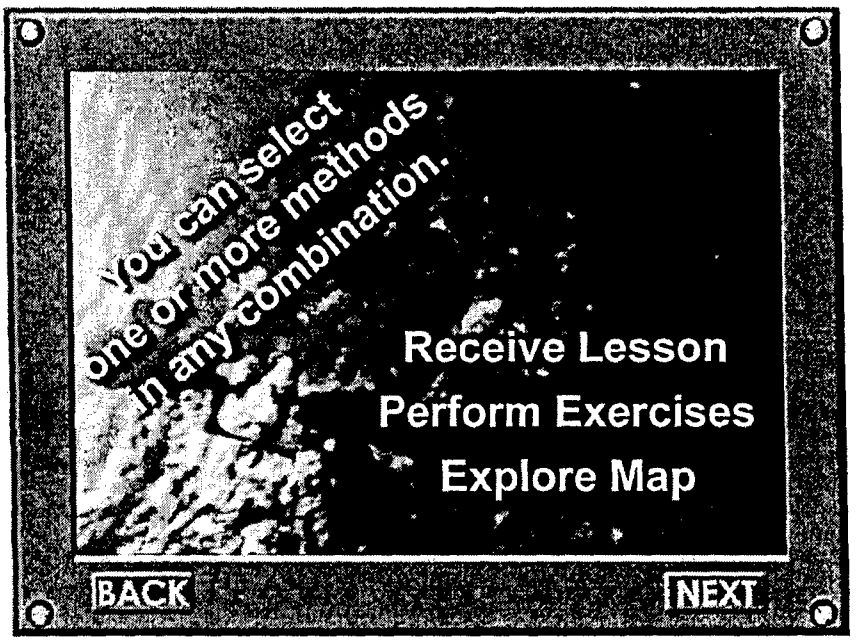
Lessons and Exercises Condition



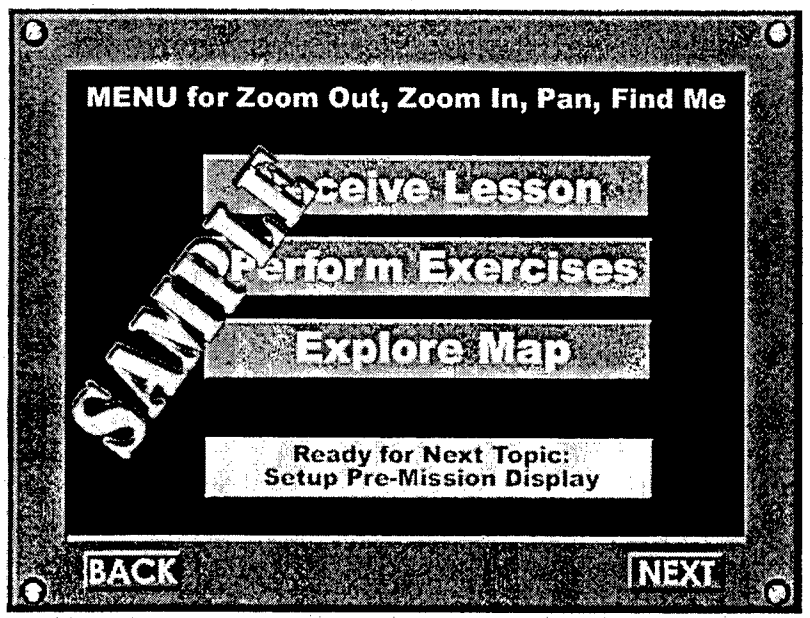
Single instruction screen for Lessons and Exercises condition.

Self-Select Condition
(Some of the Instructional Screens)

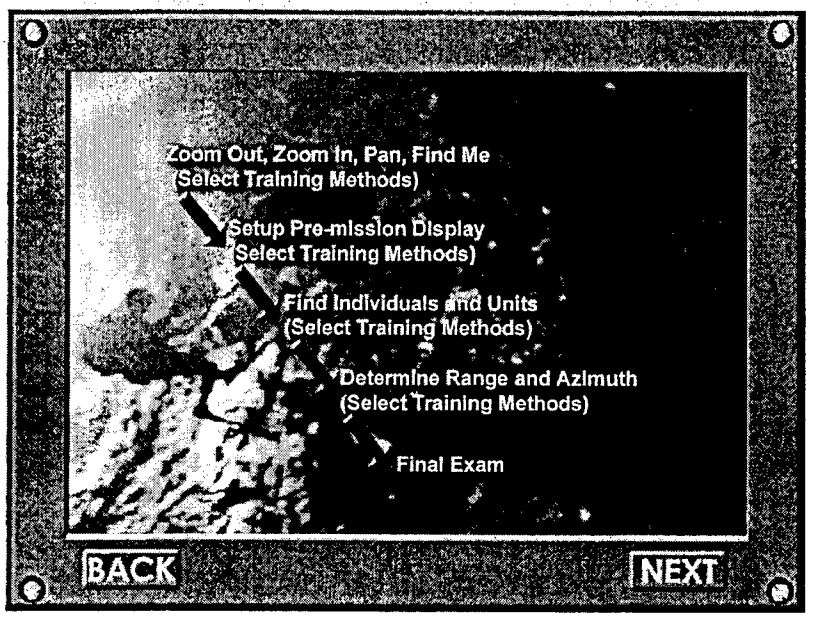
Map functions to be trained.



Informing Soldiers they can select training methods they prefer.



Example of the selection menu Soldiers will see during training.



Sequence of training showing Soldiers they can select methods for each group of map functions.

Appendix B

Experimental Instruments

Survey
Demographic Questions

IOBC Survey

Age: _____

What is your source of commission? West Point _____ ROTC _____ OCS_____

Are you Active or Reserve component/National Guard? AC _____ RC _____

Years and Months Active Duty in Army: _____years _____months

Years and Months RC/NG in Army: _____years _____months

OSUT Survey

Age: _____

What is the highest level of education you have had?
_____High School
_____Technical School
_____Less than 4 yrs of college
_____Completed 4 yrs of college
_____Other (describe) _____

We thank you for providing information on your computer background, and reactions to the computer-based training.
We appreciate your cooperation and time devoted to this survey.

Full confidentiality will be maintained in the processing of all data.

U.S. Army Research Institute for the Behavioral and Social Sciences, Ft. Benning, GA

Section A
Computer Survey

Please rate how well each of these statements describes you.	Statement 1	Statement 2
Circle any number from 1 to 10.	I seem to have a "knack" or "feel" for finding my way around a computer program.	Even if I already know one way to perform a task on the computer, I usually figure out a shortcut that will allow me to do the same task with fewer steps.
Does not describe me at all	1	1
	2	2
	3	3
	4	4
Somewhat descriptive	5	5
	6	6
	7	7
	8	8
Describes me completely	9	9
	10	10

1. When did you use computers in your education? *(Circle all that apply)*
   Grade School Jr High High School Technical School College Did Not Use

2. Where do you currently use a computer *(Circle all that apply)* [IOBC]
2. Before coming to OSUT, where did you use a computer? *(Circle all that apply)*

Home/barracks/BOQ Unit/Work Site Library/Learning Ctr/Training Facility Do Not Use

3. *For each of the following questions, circle the response that best describes you.*

a. Do you own a personal computer? Yes No

b. How often do you:

- Use a mouse? Daily, Weekly, Monthly, Less Often, Never
- Play computer games? Daily, Weekly, Monthly, Less Often, Never
- Use icon-based programs/software? Daily, Weekly, Monthly, Less Often, Never
- Use programs/software with pull-down menus? Daily, Weekly, Monthly, Less Often, Never
- Use graphics features in software packages? Daily, Weekly, Monthly, Less Often, Never
- Use E-mail (at home or at work)? Daily, Weekly, Monthly, Less Often, Never
- Use the Internet? Daily, Weekly, Monthly, Less Often, Never

4. Which of the following best describes your typing ability? (*check √one*)
   ____ Hunt and peck slowly
   ____ Hunt and peck quickly
   ____ Type slowly while not looking at the keyboard
   ____ Type quickly while not looking at the keyboard

5. Which of the following best describes your expertise with computers? (*check √one*)
   ____ Novice
   ____ Good with one type of software package (such as word processing, work calendars, slides)
   ____ Good with several software packages
   ____ Can program in one language and use several software packages
   ____ Can program in several languages and use several software packages
   ____ Expert – Bill Gates would hire me

If you are good with one or more software packages (not a novice), please list these software packages.

_____

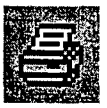
If you can program in one or more computer languages, please name these languages.

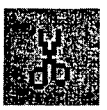
_____

6. What is the function of the following icons?

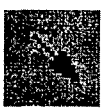


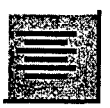




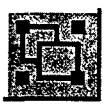













Section B
Training Survey

1. Which training was harder for you? *(circle your answer, a, b, or c)*
   a. Symbols
   b. Map
   c. They were about the same.

2. Did your previous experience with computers help during this training? *(circle your answer)*
   a. Yes
   b. No
   c. No prior experience

3. Did your previous military training help you in this training? *(circle your answer)*
   a. Yes
   b. No

   If Yes, what training helped you? _____
   _____

4. Did you have sufficient time to learn the tasks and information? *(circle your answer)*
   a. Yes
   b. No

Think Ahead Questions

5. When you encountered a think ahead question in the symbols section, did you try to answer it correctly? *(circle your answer)*
   a. Yes
   b. No

6. Did you ever click on more than one think ahead response? *(circle your answer)*
   a. Yes
   b. No

7. How difficult were the think ahead questions? *(circle your answer)*
   a. Too easy
   b. Too difficult
   c. About right

8. If you were in charge of revising the symbol lessons, would you retain or eliminate the think ahead questions? *(circle your answer)*
   a. Retain
   b. Eliminate

Symbols Training

9. **Which symbols or codes were the *easiest* to learn?** (*circle one*)

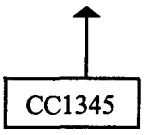
a. Symbols for weapons (rifle, machine gun)

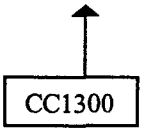
b. Symbols for units (Co, Plt, Sqd) 

c. Codes for companies (A Co = 1, ... C Co = 2 ...)

d. Codes for platoons (1st Plt = 1, ...3rd Plt = 3...)

e. Codes for squads (1st sqd = 1 ... wpns sqd = 4)

f. Codes for squad members 

g. Codes for platoon and company leaders 

h. Codes for units 

10. **Which symbols or codes were the *hardest* to learn?** (*circle one*)

a. Symbols for weapons (rifle, machine gun)

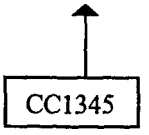
b. Symbols for units (Co, Plt, Sqd) 

c. Codes for companies (A Co = 1, ... C Co = 2 ...)

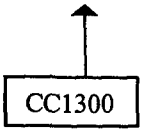
d. Codes for platoons (1st Plt = 1, ...3rd Plt = 3...)

e. Codes for squads (1st sqd = 1 ... wpns sqd = 4)

f. Codes for squad members



g. Codes for platoon and company leaders



h. Codes for units

Section C
Map Training Conditions

CONDITION 1: Expl Only *(explore map freely)*

1. Rank order the map functions from easiest to hardest to learn (1, 2, 3, and 4). Give a "1" to the easiest, and a "4" to the hardest.

   _____ a. Zooming and panning
   _____ b. Displaying units or individuals
   _____ c. Finding specific units or individuals
   _____ d. Determining range and azimuth

2. Was working with or exploring the map an effective means of training for you?
   a. Yes
   b. No

3. Did you like working with or exploring the map as a method of training?
   a. Yes
   b. No

4. Do you think lessons (formal instruction) on the map functions would have helped you? *(Circle Yes or No for **each** category of functions)*

Yes	No	a. Zooming and panning
Yes	No	b. Displaying units or individuals
Yes	No	c. Finding specific units or individuals
Yes	No	d. Determining range and azimuth

5. Do you think performing specific exercises on the map functions with immediate feedback would have helped you? *(Circle Yes or No for **each** category of functions)*

Yes	No	a. Zooming and panning
Yes	No	b. Displaying units or individuals
Yes	No	c. Finding specific units or individuals
Yes	No	d. Determining range and azimuth

Question 6 asked of IOBC Soldiers only.

6. For sustainment training, what would you prefer? (Check (√) ***each*** option you prefer.)

   _____ a. Reviewing lesson material.
   _____ b. Performing exercises where you get immediate feedback
   _____ c. Working with the map on your own.

7. Please add any comments you have about the training you just received.

CONDITION 2: Expl Exer *(solve exercises by exploring the map)*

1. Rank order the map functions from easiest to hardest to learn (1, 2, 3, and 4). Give a "1" to the easiest, and a "4" to the hardest.

   _____ a. Zooming and panning
   _____ b. Displaying units or individuals
   _____ c. Finding specific units or individuals
   _____ d. Determining range and azimuth

2. Was answering specific questions while exploring the map an effective means of training for you?
   a. Yes
   b. No

3. Did you like using exploratory exercises as a method of training?
   a. Yes
   b. No

4. Do you think lessons (formal instruction) on the map functions would have helped you? *(Circle Yes or No for **each** category of functions.)*

Yes	No	a. Zooming and panning
Yes	No	b. Displaying units or individuals
Yes	No	c. Finding specific units or individuals
Yes	No	d. Determining range and azimuth

5. After completing all the exercises, did you go directly to the map final exam, or did you choose to explore all the map functions first?
   a. Went directly to the map final exam.
   b. Went first to the full exploration option.

   If you chose full exploration, did you find that this additional time working with all the functions helped you understand them better?
   a. Yes
   b. No

6. Do you think you could have learned the map functions by just working with the map, without having exercises that gave you immediate feedback?

   a. Yes
   b. No

Question asked of IOBC Soldiers only.

7. For sustainment training, what would you prefer? (Check (√) ***each*** option you prefer.)
   _____ a. Reviewing lesson material
   _____ b. Performing exercises where you get immediate feedback
   _____ c. Working with the map on your own.

8. Please add any comments you have about the training you just received.

CONDITION 3: Lsn-Expl *(lesson then explore map)*

1. Rank order the map functions from easiest to hardest to learn (1, 2, 3, and 4). Give a "1" to the easiest, and a "4" to the hardest.

   _____ a. Zooming and panning
   _____ b. Displaying units or individuals
   _____ c. Finding specific units or individuals
   _____ d. Determining range and azimuth

2. Was having lessons followed by an opportunity to work with the map an effective means of training for you?
   a. Yes
   b. No

3. Did you like taking lessons and then working with the map as a method of training?
   a. Yes
   b. No

4. Do you think performing specific exercises on the functions with immediate feedback would have helped you?
   *(Circle Yes or No for **each** category of functions)*

Yes	No	a. Zooming and panning
Yes	No	b. Displaying units or individuals
Yes	No	c. Finding specific units or individuals
Yes	No	d. Determining range and azimuth

5. After completing instruction on all the functions, did you go directly to the map final exam, or did you choose to explore all the map functions first?
   a. Went directly to the map final exam.
   b. Went first to the full exploration option.

   If you chose full exploration, did you find that this additional time working with all the functions helped you understand them better?
   a. Yes
   b. No

6. Do you think you could have learned the map functions by just working with the map, without the lessons and without working with the map immediately after each lesson?
   a. Yes
   b. No

Question asked of IOBC Soldiers only.

7. For sustainment training, what would you prefer? (Check (√) ***each*** option you prefer.)

   _____ a. Reviewing lesson material.
   _____ b. Performing exercises where you get immediate feedback
   _____ c. Working with the map on your own.

8. Please add any comments you have about the training you just received.

CONDITION 4: Lsn-Exer *(lesson then exercise)*

1. Rank order the map functions from easiest to hardest to learn (1, 2, 3, and 4). Give a "1" to the easiest, and a "4" to the hardest.

   _____ a. Zooming and panning
   _____ b. Displaying units or individuals
   _____ c. Finding specific units or individuals
   _____ d. Determining range and azimuth

2. Was having lessons (formal instruction) followed by exercises an effective means of training for you?
   a. Yes
   b. No

3. Did you like having both lessons and exercises as a method of training?
   a. Yes
   b. No

4. Which was more helpful to you in mastering the map functions, the lessons or the exercises?
   a. Lessons
   b. Exercises
   c. Each helped me about the same.

5. Do you think that an opportunity to simply work with all the map functions on your own (explore the map) would have helped you?
   a. Yes
   b. No

Question asked of IOBC Soldiers only.

6. For sustainment training, what would you prefer? (Check (√) ***each*** option you prefer.)

   _____ a. Reviewing lesson material.
   _____ b. Performing exercises where you get immediate feedback
   _____ c. Working with the map on your own.

7. Please add any comments you have about the training you just received.

CONDITION 5: Self-Select *(choice of lesson exercises and/or exploring map)*

1. Rank order the map functions from easiest to hardest to learn (1, 2, 3, and 4). Give a "1" to the easiest, and a "4" to the hardest.

   _____ a. Zooming and panning
   _____ b. Displaying units or individuals
   _____ c. Finding specific units or individuals
   _____ d. Determining range and azimuth

2. Was selecting your method(s) of training an effective technique for you?
   a. Yes
   b. No

3. Did you like having the option of choosing the method of training?
   a. Yes
   b. No

4. Did you ever select all three methods of training?
   a. Yes
   b. No

5. Which method(s) of training did you prefer? (Circle ***one*** answer)
   a. Lessons
   b. Exercises
   c. Exploring the map
   d. Lessons and exercises
   e. Lessons and exploration
   f. Exercises and exploration
   g. All three (lessons, exercises, exploration)

6. Did you change your training strategy or did you choose the same methods for every map function?
   a. Changed the methods
   b. Used the same methods each time

Question asked of IOBC Soldiers only

7. For sustainment training, what would you prefer? (Check (√) ***each*** option you prefer.)

   _____ a. Reviewing lesson material.
   _____ b. Performing exercises where you get immediate feedback
   _____ c. Working with the map on your own.

8. Please add any comments you have about the training you just received.

Appendix C

Soldier Background Results and Reactions to Symbol Training

Demographic Results

Table C-1

Descriptive Statistics on Age in Years

Course	*N*	*M*	*Mdn*	*SD*	Range
OSUT	84	20.51	20.00	3.24	17-36
IOBC	67	24.81	24.00	2.87	20-33

Note. $F(1,149) = 72.14$, $p < .0001$. Mean age for the IOBC Soldiers was significantly higher than the OSUT Soldiers.

Table C-2

Descriptive Statistics on Months in Active Service

Course	*N*	*M*	*Mdn*	*SD*	Range
IOBC	67	19.55	11.00	24.32	4- 150
OSUT	Not applicable				

Note. Of the IOBC students, 41 (61%) received their commission through Reserve Officer Training Corps, 26 (39%) from Officer Candidate School.

Table C-3

Percentage of Soldiers Using a Computer in Different Phases of Their Formal Education

	% Use Computer					
Course	Grade School	Junior High	High School	Technical School	College	Not Use
OSUT	39%	80%	83%	6%	23%	6%
IOBC	43%	57%	64%	7%	84%	1%

Note. For the OSUT Soldiers, 38 (45%) had a high school education, 3 (3%) had technical school training, 22 (26%) had less than 4 years of college, 1 (1%) had a college degree, and 20 (23%) had a GED.

Table C-4

Number of Educational Settings Where Soldiers Used a Computer

	# Educational Settings Used a Computer (% Soldiers)					
Course	0	1	2	3	4-5	*M* Settings
OSUT	6%	14%	32%	38%	10%	2.31
IOBC	1%	31%	15%	19%	33%	2.55

Note. Mean number of settings for IOBC was not significantly different from OSUT

Table C-5
Percentage of Soldiers Indicating Computer Ownership and Current Use of a Computer

Course	% Own a Computer	% Use Computer Now	Where Currently Use Computer		
			Home	Work/ Unit	Trng Facility
OSUT	63%	87%	81%	34%	40%
IOBC	88%	98%	90%	27%	37%

[a] Own: $\chi^2(1) = 12.44, p < .0001$.
[b] Use: $\chi^2(1) = 6.85, p < .05$.

Table C-6
Descriptive Statistics on the Sum of Feature Use Ratings

Course	Sum of Feature Use Ratings					
	N	*M*	*Mdn*	*SD*	Range	Interquartile Range
OSUT	83	18.33	21.00	8.55	0-28	14-25
IOBC	67	21.66	23.00	5.51	0-28	19-25

Note. Seven features were rated on a 0 to 4-point scale, ranging from "never used" to "daily use." Maximum score was 28 representing daily use of all 7 features; minimum score was 0 indicating a Soldier never used any of the 7 features.
$F(1, 148) = 7.61, p < .05$.

Table C-7
Descriptive Statistics on Frequency of Using Specific Computer Features

Feature	OSUT[a]		IOBC[b]	
	M	*SD*	*M*	*SD*
Mouse	2.99	1.36	3.69	0.74
Internet	2.93	1.29	3.63	0.81
E-mail	2.78	1.42	3.55	0.92
Menus	2.80	1.49	3.43	0.95
Icons	2.70	1.49	3.36	1.08
Games	2.42	1.43	2.00	1.53
Graphics	1.71	1.44	2.00	1.35

Note. Maximum score was 4 for each feature indicating daily use. Minimum score was 0 for each feature indicating never used. Minimum and maximum values for each feature for each course were 0 and 4.
[a] n = 83
[b] n = 67

Table C-8
Percentage of Soldiers Indicating Different Levels of Typing Skill

Course	Self Ratings of Typing Skill			
	Hunt & Peck Slowly	Hunt & Peck Quickly	Type Slowly	Type Quickly
OSUT	9%	46%	25%	19%
IOBC	1%	31%	25%	42%

Note. $\chi^2(3) = 12.79, p < .005$.

Table C-9
Descriptive Statistics on Self-Ratings of Typing Skill

Course	Self-Ratings of Typing Skill				
	N	*M*	*Mdn*	*SD*	Interquartile Range
OSUT	84	2.54	2.00	0.91	2.0-3.0
IOBC	67	3.07	3.00	0.89	2.0-4.0

Note. $F(1, 149), = 13.27, p < .000$. IOBC mean rating higher than OSUT. Scale is the four categories shown in Table C-8.

Table C-10
Percentage of Soldiers Indicating Different Levels of Computer Skill

Course	Self-Ratings of Computer Skill						
	N	Novice	Good w 1 softw program	Good w several Soft Progr	1 Progm Lang + Software	Several Progm Lang+Soft	Bill Gates hire me
OSUT	84	50%	14%	31%	4%	1%	0%
IOBC	67	19%	21%	45%	9%	4%	1%

Table C-11
Descriptive Statistics on Self-Ratings of Computer Skill

Course	Self-Ratings of Computer Skill					
	N	*M*	*Mdn*	*SD*	Range	Interquartile Range
OSUT	84	1.92	1.50	1.03	1-4	1-3
IOBC	67	2.63	3.00	1.12	1-5	2-3

Note. Scale: Novice = 1, One software program = 2; Several software program = 3, One program language + software = 4, Program languages + software = 5; Bill Gates hire me = 6. $F(1, 149) = 16.27, p < .000$; IOBC mean rating higher than OSUT.

Table C-12
Descriptive Statistics on Icon Test Score

	Icon Test Scores					
Course	***M***	*Mdn*	*Range*	*SD*	Interquartile Range	Mean % Correct
OSUT	7.14	7.00	0-15.5	3.35	5-9	40%
IOBC	10.21	11.00	0-16	3.29	8.5-12.5	57%

Note. $F(1, 147) = 31.35, p < .001$. IOBC mean score was higher than OSUT.

Table C-13
Mean Ratings on Facility with Computer Items

	OSUT	**IOBC**	**All Groups**
Item	*M* *(SD)* *(Range)*	*M* *(SD)* *(Range)*	*M* *(SD)* *(Range)*
Have a "knack" or "feel" for finding my way around a computer	6.57 (2.12) (1-10)	7.19 (2.08) (2-10)	6.85 (2.12) (1-10)
Even if know one way to perform a task, usually figure out a shortcut	6.24 (2.33) (1-10)	6.30 (2.70) (1-10)	6.26 (2.50) (1-10)

Note. Knack: $F(1, 149) = 3.26, p = .07$. No significant differences between IOBC and OSUT Soldiers.
Shortcut: $F(1, 149) = .022, p = .88$. No significant differences between IOBC and OSUT Soldiers.
Ratings on a 10-point scale, 1 = *does not describe me at all;* **5** = *somewhat descriptive;* 10 = *describes me completely.*

General Questions about the Training

Table C-14
Responses to Questions on the Symbol and Map Training (% Soldiers)

	OSUT (n = 85)	IOBC (n = 67)	All Groups (n = 152)
Which training was harder for you?[a]			
Symbols	12%	1%	7%
Map	58%	52%	56%
They were about the same	30%	46%	37%
Did previous experience with computers help?[b]			
Yes	58%	78%	67%
No	38%	21%	30%
No prior experience	3%	1%	3%
Did previous military experience help?[c]			
Yes	56%	90%	71%
No	45%	10%	29%
Did you have sufficient time to learn the tasks and information?[d]			
Yes	83%	94%	88%
No	17%	6%	12%

[a] $\chi^2(3) = 9.3, p < .025$. [b] $\chi^2(3) = 7.10, p < .06$.
[c] $\chi^2(2) = 21.20, p < .000$. [d] $\chi^2(2) = 4.86, p < .08$.

Table C-15
Responses to the "Think-ahead" Question Technique in the Symbol Training

	OSUT (n = 84)	IOBC (n = 67)	All Groups (n = 151)
% Soldiers who tried to answer the "think-ahead" question correctly	99%	100%	99%
% Soldiers who clicked on more than one "think-ahead" response	46%	43%	45%
Difficulty of the "think-ahead" questions			
Too easy	21%	25%	23%
Too difficult	5%	0%	2%
About right	74%	75%	75%
% Soldiers who would retain the "think-ahead" questions	92%	94%	93%

Note. No significant differences between OSUT and IOBC on the four "think-ahead" questions.

Table C-16
Which symbols or codes were the easiest to learn? (% Soldiers)

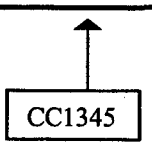
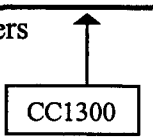
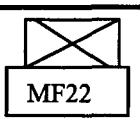
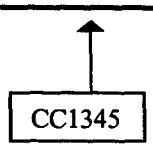
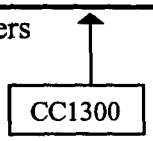
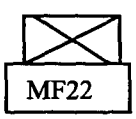
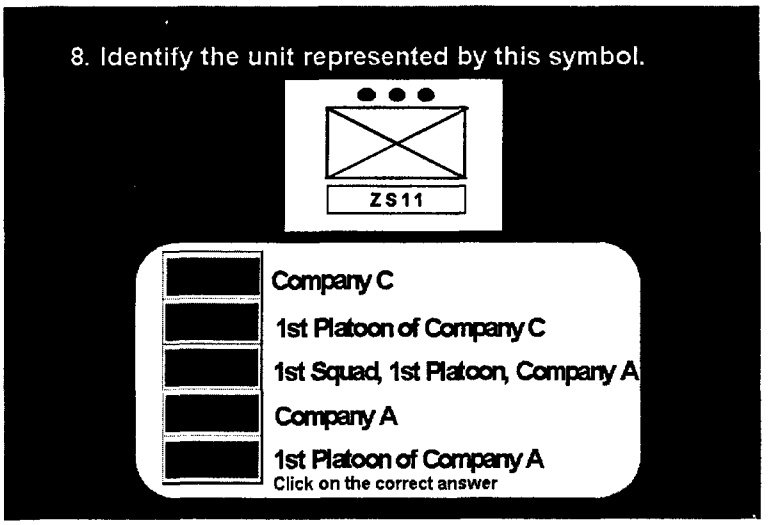
	OSUT (n = 80)	**IOBC** (n = 67)	**All Groups** (n = 147)
a. Symbols for weapons (rifle, machine gun)	84%	85%	84%
b. Symbols for units (Co, Plt, Sqd) 	8%	10%	9%
c. Codes for companies (A Co = 1, … C Co = 2 …)	2%	3%	3%
d. Codes for platoons (1st Plt = 1, …3rd Plt = 3…)	2%	0%	1%
e. Codes for squads (1st sqd = 1 … wpns sqd = 4)	1%	0%	1%
f. Codes for squad members 	0%	1%	1%
g. Codes for platoon and company leaders 	1%	0%	1%
h. Codes for units 	1%	0%	1%

Table C-17
Which symbols or codes were the hardest to learn? (% Soldiers)

	OSUT (*n* = 78)	**IOBC** (*n* = 66)	**All Groups** (*n* = 144)
a. Symbols for weapons (rifle, machine gun)	0%	1%	1%
b. Symbols for units (Co, Plt, Sqd) 	1%	0%	1%
c. Codes for companies (A Co = 1, … C Co = 2 …)	0%	0%	0%
d. Codes for platoons (1st Plt = 1, …3rd Plt = 3…)	5%	1%	3%
e. Codes for squads (1st sqd = 1 … wpns sqd = 4)	4%	3%	3%
f. Codes for squad members 	28%	48%	38%
g. Codes for platoon and company leaders 	50%	38%	44%
h. Codes for units 	12%	8%	10%



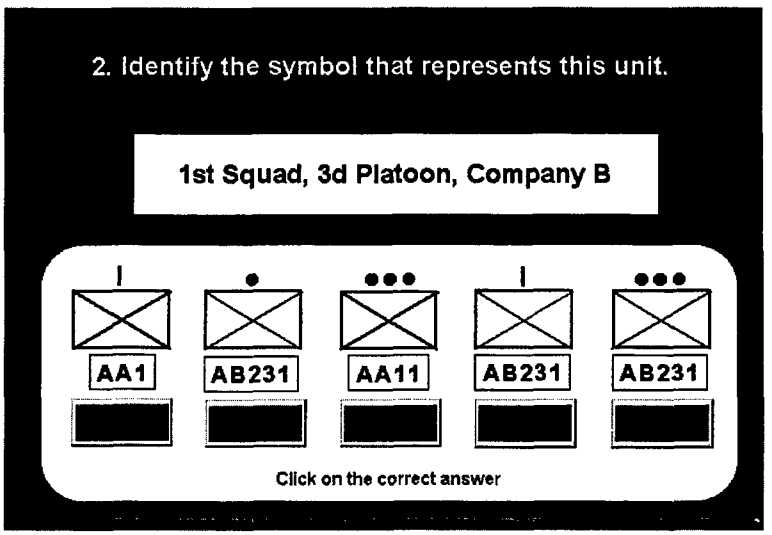


Figure C-1. Illustration of the two question formats in the key leader and unit code BR exercises.

Appendix D

Results on Symbol and Map Training

Table D-1

Analysis of Variance on Symbol Exercises

Factor	*df*	*F*	*p*
Weapon and Unit Symbols			
Soldier Group	1, 138	19.42	0.01
Map Condition	4, 138	0.40	0.81
Interaction	4, 138	0.28	0.89
Battle Roster Numbering System			
Soldier Group	1, 138	13.31	0.01
Map Condition	4, 138	0.23	0.92
Interaction	4, 138	0.62	0.65
Rifle Squad			
Soldier Group	1, 139	13.11	0.01
Map Condition	4, 139	0.49	0.74
Interaction	4, 139	0.55	0.70
Key Leader and Unit Battle Roaster			
Soldier Group	1, 139	38.34	0.01
Map Condition	4, 139	0.74	0.57
Interaction	4, 139	0.56	0.69

Note. IOBC mean score was higher than OSUT.

Table D-2

Means (Standard Deviations) for Symbol Exercises and Exam (% correct)

Course	**Symbol Training Exercise**				**Symbol Final Exam**[a]
	Wpn &Unit Symbols	**Battle Roster**	**Rifle Squad**	**Key Leaders & Unit BR**	
OSUT	95.06 (6.83) $n = 81$	90.52 (16.29) $n = 81$	93.46 (10.77) $n = 82$	80.49 (18.73) $N = 82$	88.75 (11.76) $n = 82$
IOBC	98.97 (2.33) $n = 67$	98.06 (3.98) $n = 67$	98.51 (3.03) $n = 67$	95.04 (6.15) $n = 67$	96.82 (5.49) $n = 67$
Total	96.83 (5.62) $n = 148$	93.94 (12.87) $n = 148$	95.72 (8.60) $n = 149$	87.03 (16.18) $n = 149$	92.38 (10.26) $n = 149$

[a] $F(1, 139) = 28.58$, $p < .0001$

Table D-3
Mean Time (min) to Complete Symbol Training and the Exam

Course	Statistic	Time to Complete All Symbol Training: Lessons and Exercises[a]	Symbol Final Exam Time[b]
OSUT	*M*	67:01	8:43
	SD	(12:30)	(1:57)
	n	84	84
IOBC	*M*	55:04	7:31
	SD	(10:50)	(2:24)
	n	66	66
Total	*M*	61:46	8:11
	SD	(13:11)	(2:14)
	n	150	150

[a] $F(1,140) = 41.26, p < .0001$
[b] $F(1,140) = 13.69, p < .0001$

Table D-4
Analysis of Variance on Four Sets of Map Functions

Factor	*df*	*F*	*p*
Zooming and panning			
Soldier Group	1, 78	1.48	0.23
Map Condition	2, 78	1.14	0.32
Interaction	2, 78	0.99	0.38
Find specific units or individuals			
Soldier Group	1, 70	0.02	0.88
Map Condition	2, 70	0.06	0.94
Interaction	2, 70	0.37	0.69
Display units or individuals			
Soldier Group	1, 76	18.81	0.01
Map Condition	2, 76	1.30	0.27
Interaction	2, 76	0.45	0.64
Determine Range and Azimuth			
Soldier Group	1, 70	0.96	0.33
Map Condition	2, 70	2.07	0.13
Interaction	2, 70	0.64	0.53

Note. ANOVA for conditions 2 (Explore exercises), 4 (Lessons and exercises), and 5 (self-select) only, as the other conditions did not have exercises. Sample size varied with Map function because Soldiers in the Self-select condition did not have to select exercises as a method of training.

Table D-5

Condition 5: Self-Select Patterns Chosen Ordered by Frequency of Choice

Pattern Code	OSUT				IOBC				
	Zoom	Display	Find	Range & Az	Zoom	Display	Find	Range & Az	**Total # Choices**
	# of Students								
120	7	6	5	6	3	5	5	5	42
100	1	5	9	10	4	4	4	4	41
010	1	3	5	5			1	1	16
001	1	2	2		2	1	2	2	12
123	4	2			4	1			11
132	2	1	1			1	1	1	7
102	3			1				1	4
210		3							3
021	1	1							2
201			1			1			2
231	2								2
012	1								1
213		1							1
312	1								1
000[a]			1	2					3
321	No Soldier picked this combination								
Total	24	24	24	24	13	13	13	13	148

Note. The Pattern Code has three positions. The first position represents lesson mode, second position represents exercise mode, and third position represents explore map mode. The numbers 0, 1, 2, and 3 represent the sequence in which a training mode was selected.

0 = this mode was not selected,
1 = first mode selected,
2 = second mode selected, and
3 = third mode selected.

For example, combination 120 indicates that lessons were selected first, followed by exercises. The map was not explored. Combination 132 indicates that lessons were selected first, then map exploration, and then exercises. The numbers in each cell represent the number of Soldiers who selected specific modes and sequences of training. The last column is the number of these numbers for each pattern code (row).

[a] For this combination, one OSUT Soldier did not pick any training mode for two functions (Locate Individuals via Find X and Determine Range and Azimuth). Another OSUT Soldier did not pick any training modes for Determine Range and Azimuth.

Table D-6

Condition 5 (Self-Select): Combination of Training Methods Actually Used Displayed for Each Map Function and Ordered by Map Final Score

Course	Zoom	Display	Find	Range & Azimuth	Map Final Score	# Training Modes Selected		
						3	2	1
OSUT	1 0 2	1 3 2	1 0 0	1 0 0	89	x	x	x
OSUT	0 1 2	0 2 1	0 1 0	0 1 0	86		x	x
OSUT	0 1 0	2 1 0	1 0 0	1 0 0	86		x	x
OSUT	1 2 0	1 2 0	1 3 2	1 2 0	86	x	x	
OSUT	1 2 0	1 0 0	1 0 0	1 0 0	82		x	x
OSUT	1 2 3	0 1 0	1 2 0	1 2 0	79	x	x	x
OSUT	1 2 0	1 2 0	1 0 0	1 0 0	75		x	x
OSUT	1 2 0	1 0 0	0 1 0	0 1 0	75		x	x
OSUT	0 0 1	2 1 0	1 0 0	1 0 0	75		x	x
OSUT	1 3 2	1 0 0	2 0 1	1 0 0	75	x	x	x
OSUT	1 2 0	1 2 0	1 0 0	1 0 0	71		x	x
OSUT	0 2 1	1 2 0	1 2 0	1 2 0	61		x	
OSUT	1 2 3	0 1 0	0 1 0	0 1 0	61	x		x
OSUT	1 0 0	1 0 0	1 0 0	1 0 0	57			x
OSUT	1 0 2	1 2 3	0 0 1	1 2 0	50	x	x	x
OSUT	3 1 2	1 2 0	0 0 1	1 0 2	46	x	x	x
OSUT	2 3 1	1 0 0	0 1 0	0 1 0	46	x		x
OSUT	1 2 0	0 0 1	0 1 0	0 1 0	46		x	x
OSUT	2 3 1	0 0 1	1 2 0	1 0 0	39	x	x	x
OSUT	1 0 2	0 1 0	1 0 0	1 0 0	39		x	x
OSUT	1 2 3	2 1 3	0 0 0	0 0 0	29	x		
OSUT	1 2 0	2 1 0	1 0 0	0 0 0	29		x	x
OSUT	1 2 3	1 2 0	1 2 0	1 2 0	No Score Available	x	x	
OSUT	1 3 2	1 2 3	1 2 0	1 2 0		x	x	
IOBC	1 2 3	1 3 2	1 3 2	1 3 2	96	x		
IOBC	1 2 3	1 2 3	1 2 0	1 2 0	93	x	x	
IOBC	1 2 3	1 2 0	1 2 0	1 2 0	93	x	x	
IOBC	1 0 0	1 0 0	0 1 0	0 1 0	93			x
IOBC	1 2 0	1 2 0	1 0 0	1 0 0	86		x	x
IOBC	1 2 0	1 0 0	1 0 0	1 0 0	82		x	x
IOBC	1 0 0	1 2 0	1 2 0	1 2 0	82		x	x
IOBC	1 2 3	1 2 0	1 2 0	1 2 0	82	x	x	
IOBC	1 0 0	1 0 0	1 0 0	1 0 0	79			x
IOBC	1 2 0	1 2 0	1 2 0	1 2 0	79		x	
IOBC	1 0 0	1 0 0	1 0 0	1 0 0	79			x
IOBC	0 0 1	0 0 1	0 0 1	0 0 1	71			x
IOBC	0 0 1	2 0 1	0 0 1	0 0 1	61		x	x

Table D-7
Condition 5 (Self-Select): Training Mode Selections Across all Map Functions

Methods Selected	**OSUT** (# = 93)	**IOBC** (# = 52)	**All Groups** (# = 145)	Total # Selections
Lessons and Exercises	29%	35%	31%	45
Lessons Only	27%	31%	28%	41
Lessons, Exercises and Use Map	15%	15%	15%	22
Exercises Only	15%	4%	11%	16
Use Map Only	5%	14%	8%	12
Lessons and Use Map	5%	2%	4%	6
Exercises and Use Map	3%	0%	2%	3

Note. The percentages in each column sum to 100%. Methods selected reflect using only one method or a combination of methods across the four map functions. For example, both Lessons and Exercises were selected 45 times in the Self-Select condition, considering both OSUT and IOBC Soldiers, and the four map functions. For OSUT Soldiers, 29% of their selections were lessons and exercises; the corresponding percentage for IOBC was 35%.

Table D-8
Condition 5 (Self-Select): Percentage of Selections for Each Method of Training for Each Map Functions

	OSUT				**IOBC**			
Map Functions	Training Method			# Tallies	Training Method			# Tallies
	Lesson	Exercise	Explore Map		Lesson	Exercise	Explore Map	
Zoom	46%	29%	25%	54	37%	35%	28%	24
Display	52%	30%	17%	42	42%	40%	17%	23
Find	50%	35%	15%	31	52%	35%	13%	20
Range & Azimuth	50%	35%	15%	29	58%	38%	3%	20
Mean % for All Functions	49%	32%	18%		47%	37%	15%	

Note. The percentages in each row (representing a map function) within each course sum to 100%. When a Soldier used more than one method, all methods were tallied and included in the total count. Percentages in the table were based on these tally numbers (not the number of Soldiers).

Table D-9

Condition 5 (Self-select): Relationship between Map scores and Number of Methods Selected

Number of Methods a Soldier Selected Across the Four Map Functions	Map Score	
	>= 80%	<=79%
	# (%) Soldiers	
All three methods or a combination of 2 and 3 methods	5 (15%)	0 (0%)
Combination of one or two methods	6 (18%)	6 (18%)
All other combinations (e.g., only 1 method, combination of 1, 2 and 3 methods)	2 (6%)	14 (42%)

Note. $n = 33$ (incomplete data on 4 OSUT Soldiers).

Table D-10

Map Exam Score Correlations with Self-ratings on Ability to Work Independently with a Computer and Computer Knowledge (Icon Test)

Work Independently **and Computer Knowledge Measures**	**Training Condition**				
	Explore Only	Explore via Exercise	Lesson then Explore	Lesson and Exercise	Self-Select
Shortcut	.44*	.25	-.11	.06	-.31
Knack	.17	.17	-.23	-.10	-.30
Computer Icon Score	.48*	.48*	.38*	-.15	-.18
n	25	29	28	28	33

Note. Shortcut and knack correlated significantly with each other within each training condition, with the correlations ranged from .52 to .83.

* $p < .05$, two tailed

Table D-11

Training Times (minutes) for Map Functions by Mode of Training and Training Condition

Mode of Training	Training Condition	Map Functions			
		Zoom, Pan, Find Self	Display	Find	Range Azimuth
Lessons	Explore via Exercise	NA	NA	NA	NA
	Lesson then Explore	6:16	9:28	6:50	3:48
	Lesson & Exercise	6:47	9:24	6:09	3:22
	Self-Select (optional)	6:07	9:05	5:39	3:27
		(n = 32)	(n = 31)	(n = 27)	(n = 29)
Exercises	Explore via Exercise	8:19	14:19	8:44	5:38
	Lesson then Explore	NA	NA	NA	NA
	Lesson & Exercise	8:12	9:18	7:18	4:28
	Self-Select (optional)	8:04	11:01	8:00	4:38
		(n = 26)	(n = 24)	(n = 18)	(n = 18)
Explore Map	Explore via Exercises	NA	NA	NA	NA
	Lesson then Explore	1:42	2:06	0:56	1:09
	Lesson & Exercise	NA	NA	NA	NA
	Self-Select (optional)	2:25	5:50	1:03	1:01
		(n = 22)	(n = 12)	(n = 8)	(n = 5)

Note. Explore Only condition not included as Soldiers explored all functions simultaneously – in one block of time. Sample size for Explore via Exercise and for Lesson and Exercise conditions was 29; for Lesson then Explore, it was 27. A total of 35 Soldiers were in the Self-Select condition.

Appendix E

Reactions to Map Training

CONDITION 1: Exploration Only *(explore map freely)*

26 Soldiers (13 OSUT, 13 IOBC)

Table E-1
Condition 1: Reactions to Method of Training Used

Questions	OSUT	IOBC	All Groups
	% Soldiers answering "Yes"		
Exploring the map was an effective means of training	46%	77%	61%
Liked exploring the map as a method of training	62%	77%	69%

Table E-2
Condition 1: Reactions to Methods of Training Not Used

Map Functions	OSUT	IOBC	All Groups
	% Soldiers indicating lessons/formal instruction on map functions would have helped		
Zooming and panning	54%	31%	42%
Display units or individuals	77%	77%	77%
Finding specific units or individuals	69%	61%	65%
Determining range and azimuth	77%	23%	50%
	% Soldiers indicating map exercises with feedback would have helped		
Zooming and panning	69%	31%	50%
Display units or individuals	83%	92%	85%
Finding specific units or individuals	83%	92%	85%
Determining range and azimuth	77%	46%	61%

CONDITION 2: Explore Exercises *(solve exercises by exploring the map)*

31 Soldiers (18 OSUT, 13 IOBC)

Table E-3
Condition 2: Reactions to Method of Training Used

Questions	OSUT	IOBC	All Groups
	% Soldiers answering "Yes"		
Answering questions while exploring the map was effective means of training	94%	92%	93%
Liked exploratory exercises as a method of training	89%	77%	84%

Table E-4
Condition 2: Reactions to Methods of Training Not Used

Map Functions	OSUT	IOBC	All Groups
	% Soldiers indicating lessons/formal instruction on map functions would have helped		
Zooming and panning	33%	38%	35%
Display units or individuals	56%	46%	52%
Finding specific units or individuals	44%	54%	48%
Determining range and azimuth	50%	38%	45%
	% Soldiers indicating they could have learned map functions by just working with the map (no exercises with feedback)		
	33%	69%	48%

Table E-5
Condition 2: Reaction to Option of Exploring Map after Exercises

	OSUT	IOBC	All Groups
	% Soldiers answering "Yes"		
Went directly to the map final exam vs. using the full exploration option	83%	77%	81%

Note. Of the 19% who used the full exploratory option, half said it helped them and half said it did not help them.

CONDITION 3: Lesson then Exploration *(lesson then explore map)*

28 Soldiers (14 OSUT, 14 IOBC)

Table E-6
Condition 3: Reactions to Method of Training Used

Questions	OSUT	IOBC	All Groups
	% Soldiers answering "Yes"		
Having lessons followed by opportunity to work with map was effective means of training	100%	79%	89%
Liked having lessons followed by opportunity to work with map	86%	86%	86%

Table E-7
Condition 3: Reactions to Methods of Training Not Used

Map Functions	OSUT	IOBC	All Groups
	% Soldiers indicating exercises with feedback would have helped		
Zooming and panning	57%	57%	57%
Display units or individuals	71%	86%	79%
Finding specific units or individuals	86%	86%	86%
Determining range and azimuth	79%	71%	75%
	% Soldiers indicating they could have learned map functions by just working with the map (no exercises with feedback)		
	36%	57%	46%

Table E-8
Condition 3: Reaction to Option of Exploring Map after Exercises

	OSUT	IOBC	All Groups
	% Soldiers		
Went directly to the map final exam vs. using the full exploration option	79%	93%	85%

Note. Of the 15% who used the full exploratory option, twice as many said it helped them as opposed to not helping them.

CONDITION 4: Each Lesson followed by Exercises *(lesson then exercise)*

30 Soldiers (16 OSUT, 14 IOBC; total number who participated in Condition 4))

Table E-9
Condition 4: Reactions to Method of Training Used

Questions	OSUT	IOBC	All Groups
	% Soldiers answering "Yes"		
Having lessons followed by exercises was an effective means of training	100%	100%	97%
Liked lessons than exercises as a method of training	100%	85%	90%

Note. One IOBC Soldier did not answer these questions. Percentages based on number of Soldiers who answered.

Table E-10
Condition 4: Mode of Training Which Helped the Most

Training Mode	OSUT	IOBC	All Groups
	% Soldiers checking each option		
Lessons	6%	8%	7%
Exercises	44%	38%	41%
Each helped about the same	50%	54%	52%

Note. One IOBC Soldier did not answer this question. Percentages based on number of Soldiers who answered.

Table E-11
Condition 4: Reaction to Potential Value of Exploration with the Map

Question	OSUT	IOBC	All Groups
	% Soldiers who said "Yes"		
Exploration with the map would have helped	81%	77%	79%

Note: One IOBC Soldier did not answer this question. Percentages based on number of Soldiers who answered.

*

CONDITION 5: Self-Select *(choice of lessons, exercises and/or exploring map)*

37 Soldiers (24 OSUT, 13 IOBC; total number who participated in Condition 5)

Table E-12
Condition 5: Reactions to Mode of Training Used

Questions	OSUT	IOBC	All Groups
	% Soldiers who answered "Yes"		
Selecting methods of training was an effective techniques	87%	100%	92%
Liked selecting methods of training	87%	100%	92%
Selected all three modes at least once	56%	15%	42%

Note. One OSUT Soldier did not answer the first two questions; one did not answer the last question. Percentages based on number of Soldiers who answered.
Based on the computer records, 50% of the OSUT Soldiers selected all three modes at least once; 27% of the IOBC Soldiers selected all three modes at least once.

Table E-13
Condition 5: Preferred Methods of Training

Method of Training	OSUT	IOBC	All Groups
	% Soldiers		
Lessons	30%	23%	28%
Exercises	30%	15%	25%
Exploring the map	0%	15%	6%
Lessons and exercises	30%	38%	33%
Lessons and exploration	0%	0%	0%
Exercises and exploration	0%	0%	0%
All three (lessons, exercises, exploration)	9%	8%	8%

Note: Two OSUT soldiers did not answer this question. Percentages based on number of Soldiers who answered.

Table E-14
Condition 5: Consistency in Training Strategy

Strategy	**OSUT**	**IOBC**	**All Groups**
	% Soldiers		
Changed the methods	36%	23%	31%
Used the same methods each time	64%	77%	69%

Note. Four OSUT soldiers omitted this question. Percentages based on number of Soldiers who answered.

Based on the computer records, only 21% of the all the OSUT Soldiers used the same methods at least 75% of the time (on 3 of the four map functions). On the other hand, 77% of the IOBC Soldiers used the same methods at least 75% of the time.

Sustainment Training
(IOBC Soldiers only)

Table E-15

Preferred Combination of Methods for Sustainment Training: Number of IOBC Soldiers

Methods Selected	Total # (%)	Number of Responses by Experimental Condition				
		1: Explore	2: Explore Exercises	3: Lessons & Explore	4: Lessons & Exercises	5: Self Select
Exercises Only	26 (39%)	5	7	6	4	4
Exercises & Use Map	14 (21%)	3	3	4	1	3
Lessons, Exercise, & Use Map	9 (14%)	4	1	2	1	1
Use Map only	8 (12%)	0	1	2	4	1
Lessons & Exercises	5 (7%)	1	1	0	2	1
Lessons only	4 (6%)	0	0	0	1	3
Lessons & Use Map	0 (0%)	0	0	0	0	0

Note. Soldiers could select more than one method. 13 Soldiers per condition, except Condition 3 which had 14.

Note. Question: *For sustainment training what would you prefer (check each option you prefer). a. Reviewing lesson material; b. Performing exercises where you get immediate feedback; c. Working with the map on your own.*

Table E-16

Percent IOBC Soldiers Marking Each Method of Training as a Preferred Means for Sustainment (regardless of whether another method was checked)

Method	Total # (%)	Percent Soldiers by Experimental Condition				
		1: Explore	2: Explore Exercises	3: Lessons & Explore	4: Lessons & Exercises	5: Self Select
Exercises	54 (82%)	100%	92%	86%	62%	69%
Use Map	31 (47%)	54%	38%	57%	46%	38%
Lessons	21 (32%)	38%	15%	14%	31%	38%

Note. Soldiers could select more than one method. 13 Soldiers per condition, except Condition 3 which had 14.

Table E-17
Means and Percentages for Rank Order of Map Function Difficulty

Map Functions	**Difficulty of Map Functions**				
	% Soldiers			*Mean Rank*	
	Rank	OSUT	IOBC	OSUT	IOBC
Zooming and panning	1	68%	65%	1.53	1.68
	2	20%	18%		
	3	4%	0%		
	4	8%	17%		
Display Units or Individuals	1	6%	8%	2.81	3.00
	2	33%	13%		
	3	33%	50%		
	4	28%	29%		
Find units or Individuals	1	3%	3%	3.20	3.24
	2	13%	17%		
	3	46%	33%		
	4	38%	47%		
Determine Range and Azimuth	1	34%	24%	2.18	2.08
	2	34%	51%		
	3	11%	17%		
	4	21%	8%		

Note. OSUT $n = 82$ IOBC $n = 66$. Rank of 1 = easiest; rank of 4 = hardest.